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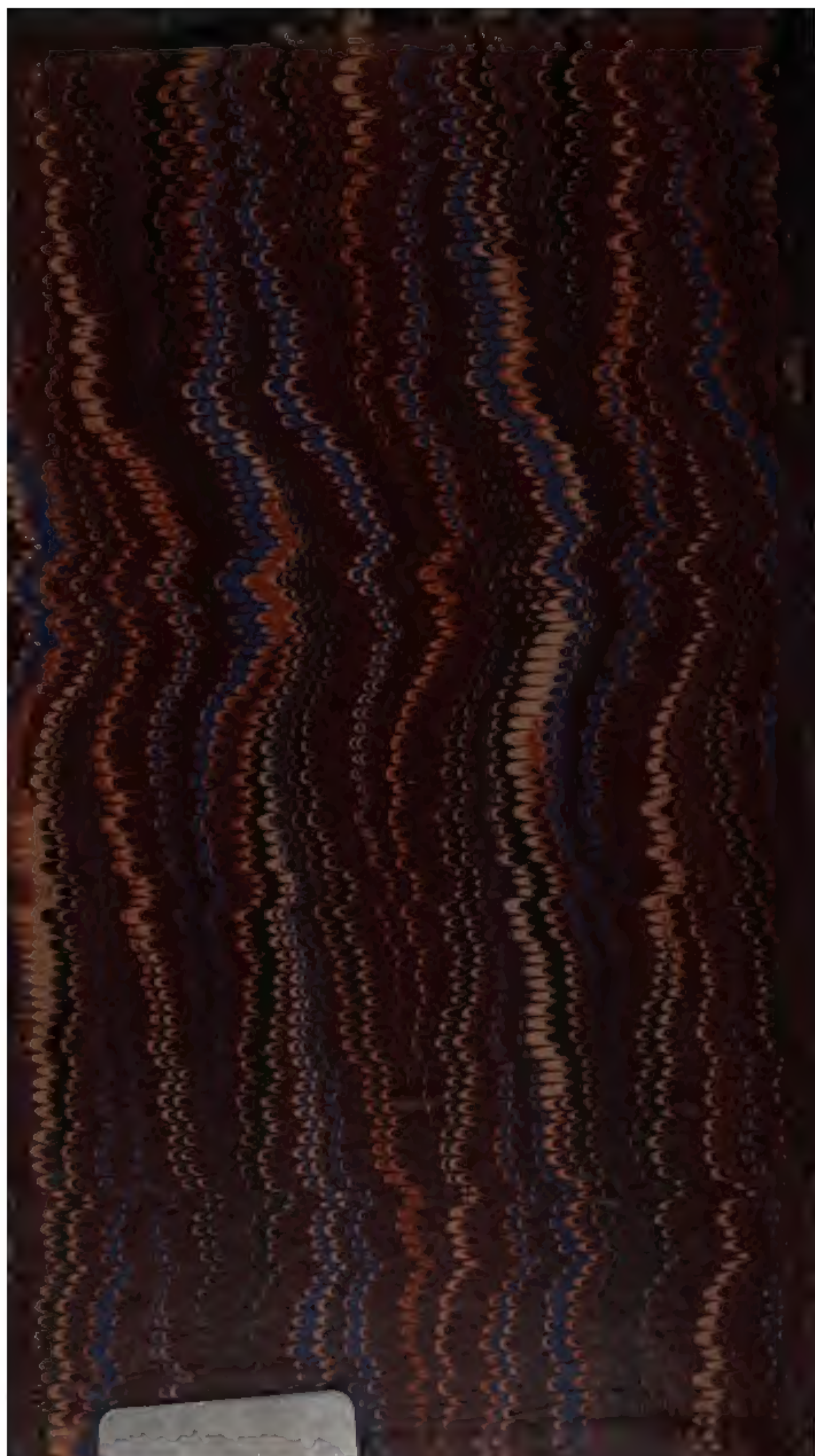
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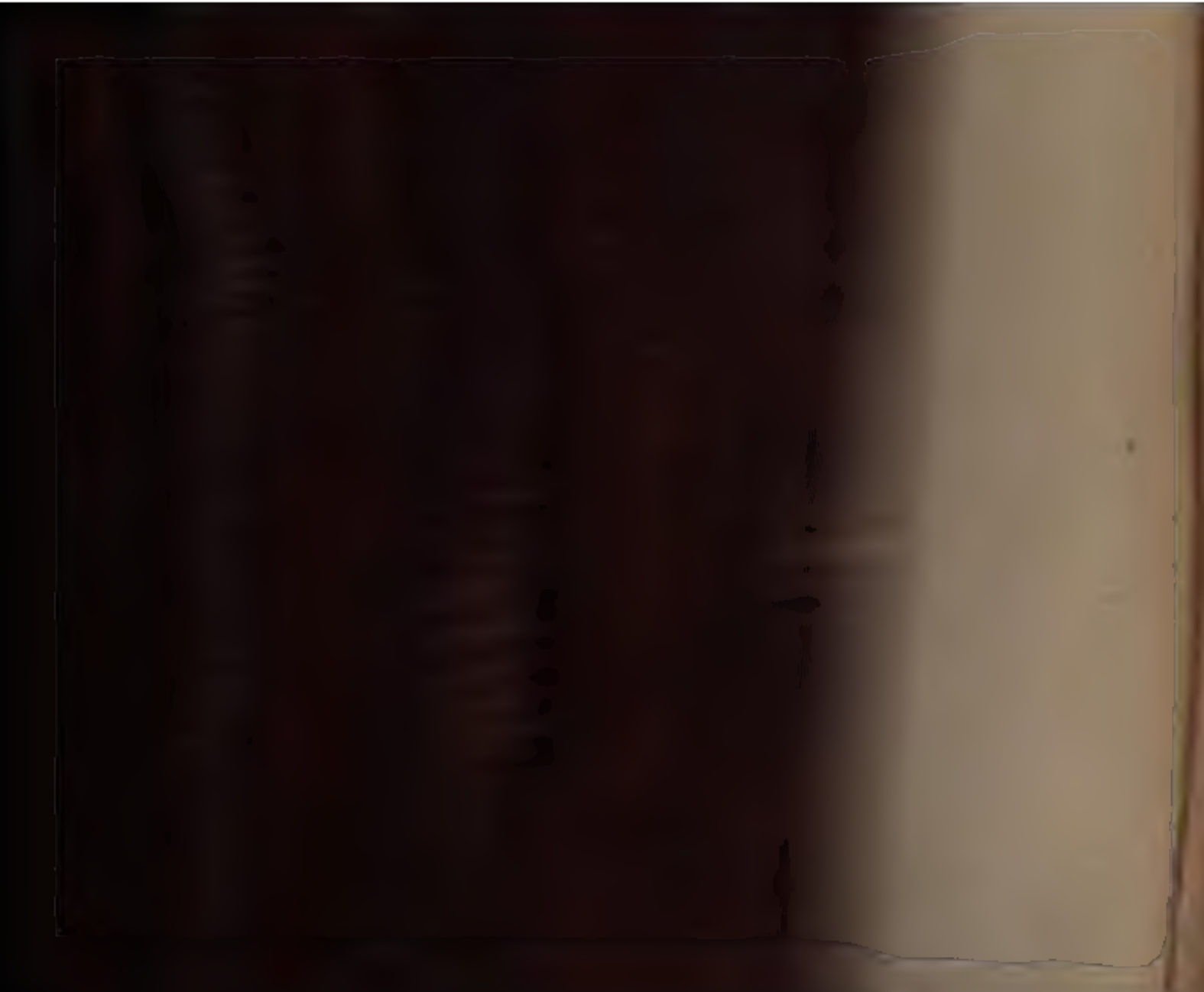
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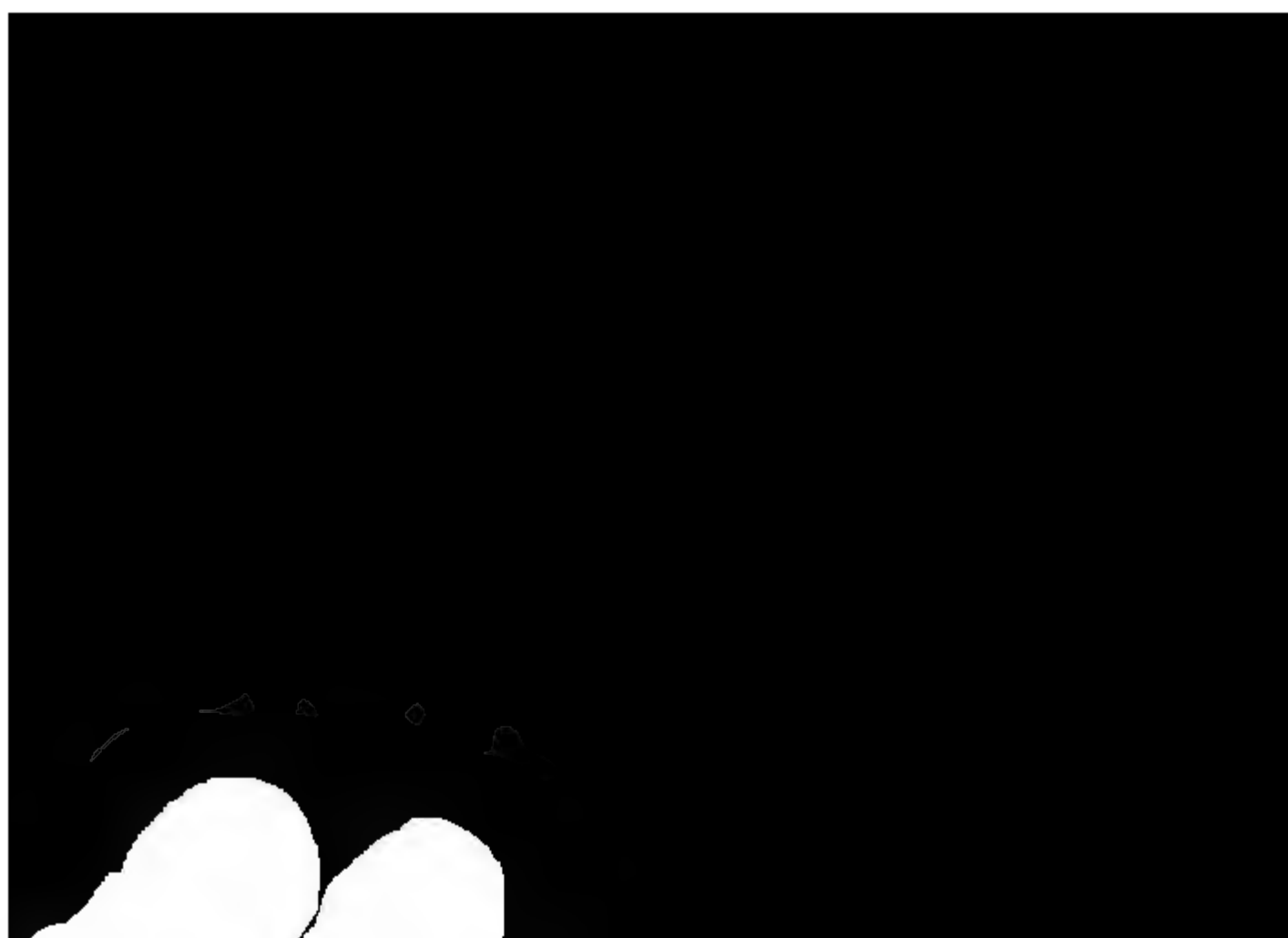








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ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA,
February 17, 1879.

I hereby certify that printed copies of the Proceedings for 1878 have been presented at the meetings of the Academy, as follows:—

Pages	9 to 24	.	.	.	March	5, 1878.
"	25 to 56	.	.	.	April	2, 1878.
"	57 to 88	.	.	.	"	9, 1878.
"	89 to 104	.	.	.	May	21, 1878.
"	105 to 120	.	.	.	June	4, 1878.
"	121 to 136	.	.	.	"	18, 1878.
"	137 to 152	.	.	.	"	25, 1878.
"	153 to 200	.	.	.	July	23, 1878.
"	201 to 216	.	.	.	"	30, 1878.
"	217 to 264	.	.	.	August	6, 1878.
"	265 to 280	.	.	.	"	27, 1878.
"	281 to 328	.	.	.	November	9, 1878.



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PROCEEDINGS
OF THE
ACADEMY OF NATURAL SCIENCES
OF
PHILADELPHIA.

1878.

JANUARY 1, 1878.

The President, Dr. RUSCHENBERGER, in the chair.

Thirteen members present.

The following papers were presented for publication:—

**“Notes on the Natural History of Fort Macon, N. C., and
Virginia No. 4,” by Elliott Cones, M.D., and H. C. Yarrow, M.D.**

**“On the Mechanical Genesis of Tooth Forms,” by John A.
Ryder.**

JANUARY 8.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-one members present.

**The deaths of J. P. Kirtland, member, and Dr. Louis Pfeiffer,
and Prof. C. Nees Von Esenbeck, correspondents, were an-
nounced.**

JANUARY 15.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-six members present.

A paper entitled “Descriptions of New Species of Invertebrate

Fossils from the Carboniferous and Upper Silurian Rocks of Illinois and Indiana," by C. A. White, M.D., was presented for publication.

Boring of Corollas from the Outside by Honey-Bees.—Mr. THOMAS MEEHAN referred to the practice of the humble-bee in boring the corolla instead of entering by the mouth, even when there might be no great difficulty in doing so. A few years ago it was not noticed that any flowers were despoiled of their sweets in this extraneous way, but it was now known that the list of plants so treated was very large, and the humble-bee in America had already lost considerable of its reputation as an agent in the cross fertilization of flowers. He had carefully watched the honey-bee for some years, but could never feel sure that it also bored the corollas in the same way, for though he had often seen them working from the outside, he suspected that they used the holes made by the humble-bee. Mr. Ryder, at one of our meetings, had insisted that the honey-bee did actually work occasionally in this way, and Mr. Meehan said he was thus led to go over the subject again, proving Mr. Ryder to be right. Late in the autumn, long after most other flowers were gone, and with no humble-bees about, scarlet sages, *Salvia splendens*, for nearly a week together, received the sole attention of the honey-bees, which worked among the flowers in great numbers, in all cases boring the corollas near the base from the outside.

In connection with this fact, he said that among the scarlet sages were a large number of the pure white variety, but the bees visited them precisely as they did the scarlets, going to either indiscriminately. As bees usually contrive to work on one kind

entered it lifted the lever, and forced the true anther on the back of the insect, which thus carried pollen to another flower to be brushed against the stigma on entering. It was clear that, however reasonable this seemed hypothetically, it could have little foundation in fact in these long-tubed *Salvias*. An insect of the honey-bee size could not enter, and a smaller one that could, would not be large enough to reach the stigmas which were high up at the apex of the arch of the corolla. Only long-tongued moths could extract honey by way of the mouth; but as they thrust only their tongues into the flowers, keeping their bodies outside, the lever-like adaptation to the bodies of insects, as suggested by the prevailing hypothesis, had no force.

Cerebral Convolution of the Negro Brain.—Dr. A. J. PARKER remarked that as yet our knowledge of the cerebral convolutions in the various races is very scanty. Gratiolet, Marshall, and a few other investigators, have published descriptions of single brains, and have pointed out certain peculiarities existing in them. Beyond this, however, little has been done, and the object of the present communication is to direct attention to some of the principal points noticed in the study of thirteen negro brains, and one mulatto.

Gratiolet, in his studies of the brain of the Hottentot Venus, related that in the normal position of the brain, the island of Reil was distinctly visible. Marshall afterwards found the same peculiarity in the brain of a Bushwoman, and suggests the probability that it is a characteristic of the Bosjes Brain; citing the opinion of G. Cuvier that the Hottentot Venus was really a Bushwoman, and not a Hottentot. In studying the negro brain as it presents itself in this country, Dr. Parker had found the same condition well marked in nine cases, and perceptible in the remaining four. It would thus seem to be characteristic of the race rather than of the Bosjes alone. In the brain of a mulatto, the convolutions of which were exceedingly well developed, the same peculiarity was found, although not to so marked an extent as in the negro. Since it is thus capable of being transmitted when two races are crossed with another, it would appear to be a definite and strongly marked peculiarity. Although this condition of the negro brain is fatal in its character, as was noted by Gratiolet and Marshall, it is not found in the adult brain of any monkey thus far described.

The Sylvian fissure, also, presents certain characteristics. In the white, this fissure ascends obliquely upwards and backwards. In the Bushwoman, Marshall found that it assumed at its anterior portion a horizontal direction, the posterior portion taking a direction nearly perpendicular to this. He also points out the same peculiarity in the figure given by Gratiolet of the Hottentot Venus. This peculiarity of the Sylvian fissure was also found in

which lies between the lower end of the posterior central convolution and the upper end of the fissure of Sylvius, the supra-marginal lobule of Gratiolet, was described by him as peculiar to the human brain. It is, however, represented in the brain of the apes, although not expanded and developed into a lobule, as it is in man. A careful study of the negro brains at his disposal, had shown that even this excess of development is not absolutely characteristic of the human brain. In one negro brain the photograph of which was presented, this lobule is entirely absent, the brain showing a deficiency in this region greater in proportion than is found in the apes. The interparietal fissure runs directly into the upper end of the Sylvian, their place of union being directly back of the posterior central convolution; consequently there is absolutely no supra-marginal lobule developed. In the brain of the Bushwoman described by Marshall this lobule was present, relatively well developed, although smaller, according to this author, than is found in the European. It was marked by several secondary sulci. It was, however, better developed than in the Hottentot Venus, being larger, more complex, and projecting to a greater extent over the Sylvian fissure. In the brain above described it was, therefore, more ape-like than in either the Bushwoman or Hottentot Venus. In the remaining negro brains examined, this lobule presented itself in variously developed conditions. In two cases it was small, and not marked by any secondary fissures. The remaining brains approached more towards the condition as found in the white race, but were all less complex and smaller than is the case in the latter. In the mulatto it was as well developed as is ordinarily found in the white.

He then passed to the consideration of the occipital lobe, and here the negro brain displays its ape-like peculiarities to a greater extent than in any other portion of the cerebral surface. This lobe, as it is found represented in the apes, is comparatively simple. It is separated from the parietal lobe by a well-marked transverse fissure, the so-called perpendicular fissure; the mesial portion, corresponding to the fissure known in the human brain as the parieto-occipital, is called the internal perpendicular, while the lateral portion is known as the external perpendicular fissure. In most of the monkeys, such as *Cebus*, *Cynocephalus*, *Cercopithecus*, *Macacus*, etc., these two fissures are continuous; but in man and the higher apes, such as the Orang, Chimpanzee, etc., they are separated into two distinct fissures by the development of a bridging convolution, the so-called superior external transition or connecting convolution, the *pli de passage supérieur externe* of Gratiolet. The same condition is also found in *Ateles* and *Hylobates*. In man this convolution is largely developed, and alters, to a great extent, the appearance of this region as found in the apes. This convolution he had found invariably smaller, less developed, and simpler in the negro than in the

white. In one negro brain it was so imperfectly developed that the internal and external perpendicular fissures were superficially continuous. The fissure corresponding to the external perpendicular is also better developed in the negro.

It has been asserted that the separation of the parieto-occipital fissure on the mesial surface from the calcarine, by means of the lower internal connecting convolution (*pli de passage inférieur interne*, Gr.), is characteristic of the ape as distinguished from the human brain. Huxley has shown, however, that in the brain of *Ateles paniscus* the parieto-occipital and calcarine join each other; and Bischoff has remarked the same circumstance as existing in *Hylobates*. In all other monkeys and apes, as far as present observation extends, the parieto-occipital is separated from the calcarine by this convolution. Bischoff states that this convolution is always present in man, but is deeply sunk within the depths of the parieto-occipital fissure. Ecker also describes this as represented in man as a deeply concealed convolution under the name of the *gyrus cunei*. That this entering of the parieto-occipital into the calcarine is not a characteristic always found in the brain of man was shown by the photograph of a negro brain, which showed this convolution as well developed as it is in the apes, presenting a width of nearly one-quarter inch superficially, and separating completely the parieto-occipital from the calcarine. This is the first human brain in which this complete separation has been pointed out. It is the mesial surface of the same brain in which was noticed the complete absence of the supra-marginal lobule, and these two points, and the large and simply marked occipital lobes, in connection with numerous other points, stamps this brain as the most ape-like of human brains yet described. It

inferior internal connecting or bridging convolution visible superficially, and completely separating the parieto-occipital from the calcarine, etc.

JANUARY 22.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-six members present.

The death of Edward Tatnall, Jr., was announced.

Habits and Intelligence of Vespa maculata.—Mr. THOMAS MEEHAN exhibited young branches of *Fraxinus excelsior*, and of the common lilac, which had been stripped of their bark during the summer by the large yellow hornet. The insects had been carefully watched at the work. They visited these trees in large numbers, and carried the strips of bark away in their mouths. For what purpose they used the bark could not well be ascertained. It was generally supposed that they collected the matter from which their huge nests of paper-like material were made, from fences and other dead woody matter. He thought it remarkable that the insect should collect from plants of the same natural order only, as far as careful examination of other plants in the vicinity could decide. This hornet, he observed, was gifted with great intelligence; on an occasion he had observed one with a summer locust, several times its own size, endeavoring to rise with it from the ground and fly away, but failed from the great weight of the locust. It then walked with its prey about thirty feet to a tall maple, which it ascended to the top, and then flew off with its burden in a horizontal direction. There was more than instinct in this act. There was reasoning on certain facts and judgment accordingly, and the insect's judgment had proved correct.

JANUARY 29.

The President, Dr. RUSCHENBERGER, in the chair.

Forty-seven members present.

A paper, entitled "On the Association of Grossularite, Zoisite, Heulandite, and Leidyite, a new Species," by Geo. A. Koenig, was presented for publication.

The Mode of Recognition among Ants.—The following statements were made by Mr. McCook of certain tentative experiments upon two species of ants, as to the mode of recognizing each other,

and distinguishing fellow formicarians from congeners of alien nests.

Every dweller within town walls is familiar with the little creatures popularly known (in some quarters at least) as the "pavement ants," and known in myrmecology under the name of *Tetramorium cæspitum*. Early in the spring, as soon as the season has gathered a comfortable degree of warmth, these insects are seen issuing from the gravel or soil of garden walks, or from the earthen seam that binds together the bricks of the pavement. Around the openings whence the ants issue, are seen small circular mounds of sand or soil which have been accumulated by the out-bringing, one by one, of the particles of earth. But the chief notoriety of these ants, not unlike their fellow-creatures of the genus *homo*, is due to their martial instincts. Hundreds, even thousands, of them are often seen waging battle with great ferocity and persistence. One battle, which was noted close by the wall, within the inclosure of a church on Broad Street and Penn Square, was prolonged for a period of two weeks and several days. At least the same spot, during that period, whenever observed, showed always the same phenomena of a battle-field, the contestants of which were apparently the same. Two points of great interest have arisen concerning these Amazonian emmets—for they are veritable Amazons, the warriors being composed wholly of the *workers* or *neuters*, who are undeveloped females.

First, why do they fight at all? They are of one species, apparently of one formicary or nest. The very first act upon issuing from the winter quarters is to engage in this war, which is often well nigh a war of extermination on both sides. Frequently throughout the season these hostilities are renewed. If the indi-

in a continual motion, the tips describing parabola and circles. At the meeting these organs touch and embrace the face; if the parties be friends they pass on, if foes they straightway interlock mandibles and "fall to." Here one will see many scores of ants struggling together in a heap that is chaos to mortal eyes, but which seems to the emmet senses to present no difficulties in the way of recognition. Smaller groups are scattered over the battle-field; these are often aggregated as follows: two individuals in conflict are joined by a third, who applies her antennæ, distinguishes the enemy, and falls upon her. A fourth, fifth, many other ants, will sometimes thus be found massed upon one poor warrior, who is literally being torn limb from limb. Other groups are composed of several members of one faction and many of another. There are frequent instances of single combats, particularly on the margin of the battle-field, but toward the centre of conflict it appears to be quite the fixed habit of these groups to be composed as above. Evidently, anything like chivalry or "fair play" is rejected from the code of emmet honor. In all these cases, however, the power of recognition never seems for a moment to waver or even hesitate.

It occurred to Mr. McCook that this recognition was based upon a certain odor which in *different degrees of intensity* is emitted by the respective factions. Or, which seems less likely, upon the presence in the individuals of the combatants of *two distinct odors*. This degree of odor, or difference in odors, he supposed might be dependent upon some temporary difference in the physical condition, age, or environment of the antagonists. Supposing that there were any basis of truth in this theory, it further occurred to him that the presence of an artificial and alien perfume of sufficient strength to neutralize the distinctive animal odors, or degrees of odor, and environ the combatants with a foreign and common odor, would have the tendency to confuse the ants and disturb or destroy their power of recognition. In which case he conjectured that the result might be their pacification and reconciliation. He therefore made the following tests:—

First, he collected a number of combatants from a battle being fought upon a flower-border, close to a fence, at his residence, and placed them together in a glass jar upon some soil. He shook the jar quite vigorously several times, so that, if possible, the mechanical agitation might separate the combatants. The ants emerged from the soil to continue or to recommence their fight. When the surface of the earth was well covered with them, and the battle was again at its height, he introduced into the jar a piece of paper saturated with cologne water. The effect was instantaneous. The ants showed no signs of pain, displeasure, or intoxication. Indeed, some ran freely over the paper. But in a very few seconds the warriors had unclasped mandibles, released their hold of enemies' legs, antennæ, and bodies, and after a mo-

mentary confusion began to burrow galleries in the earth with the utmost harmony. On the part of some there was the appearance of thus escaping from the artificial odor; but there was no renewal of the battle. The quondam foes dwelt together for several days in absolute unity and fraternity, amicably feeding, burrowing, and building. Thus the perfume of the cologne proved an eminent pacificator of the contending emmets, and so far verified the theory.

A second experiment was tried in another glass jar, with like result. There was one exception, two ants continuing to fight after the cologne had been introduced. After closer examination Mr. McCook found that one of them was nearly dead, and was holding fast an antenna of her enemy with a death grip, from which escape was impossible. Three days after this he decanted the contents of this jar, ants and soil, into jar No. 1, and the two parties fraternized completely.

A third experiment was made. A large number of the warring ants had been lifted into a box, partly filled with soil, which communicated by a glass tube with a smaller box. The larger box was about ten inches long and eight inches in depth and width; both boxes had sliding glass covers. The original purpose was to observe the battle at leisure, determine how long the creatures would fight, and also if eventually the parties might not separate and the defeated retreat to the smaller box. However, he concluded to follow up the above observations, and abandoning his first purpose, introduced cologne as before into that end of the box in which the combatants were principally engaged. The same effect followed. In less than two minutes every sign of hostility had ceased, except in the case of two pairs, in that end of the box, and of one small group and two single combatants on the other

Attention was next directed to our large Pennsylvania Carpenter ant (*Camponotus Pennsylvanicus*), and a series of experiments made of the same nature as the above. In his study was an artificial formicary of those insects, which had been sent to him from the Allegheny Mountains. The ants had been taken from a branch of an oak tree in mid-winter, and were sent frozen up within a section of the formicary. This section was about one foot in length and seven inches in diameter. The most of the ants were removed from the nest and placed in a glass bottle, to all appearance quite dead. On entering his study the following morning, Mr. McCook was surprised to find that the ants had revived in the heat of the room, had cut a clean tubular hole through the cork, and were crawling over the top and sides of the bottle, just ready for an emigration. They were deposited in a large glass jar, and were the subjects of various experiments, until the death of the queen, eight months thereafter. Among these were the following, by way of further testing the theory above stated concerning the recognition of alien ants. First, Mr. McCook placed in the formicary, which at the time consisted of a piece of the original branch-nest planted upon several inches of soil, some individuals of the same species taken from the trees in Logan Square, Philadelphia. These were instantly attacked, and were beheaded, that being the favorite mode of dealing with enemies among these Pennsylvania *Camponoti*. Individuals (still a part of the same species) were then thoroughly covered with the perfume of cologne and put into the formicary. They, too, suffered decapitation. Individuals were now taken from members of the formicary, subjected to the cologne fumigation, and restored to the nest. They were welcomed home unharmed. The whole formicary was then strongly perfumed by means of cotton pellets soaked in cologne, and alien ants of the same species from Logan Square, which had been treated in the same way, were put into the midst of their mountain congeners. The result which had followed in the previous experiments, appeared once more. The intruders were not attacked with quite the same promptness, but in the end they were brought to the mandibular guillotine, and their carcasses deposited in or rather on the cemetery which these insects are nearly always sure to establish when there are numerous deaths among them or on their premises. Thus the results of these experiments upon the mode of recognition among ants of *C. Pennsylvanicus*, point to a conclusion directly the reverse of that indicated by similar observations with *Tetramorium*.

• Mr. McCook hopes when a favorable opportunity again presents to continue this line of observations. The results are put on record, inconclusive as they appear, not only because they seem to be in themselves interesting and valuable, but in order to stimulate inquiry among others in the same direction, and to invite suggestions and information which other observers may be able to make.

Dr. C. N. Peirce was elected a member of the Council in place of Dr. R. S. Kenderline elected Curator.

Messrs. S. Fisher Corlies and Clarence S. Bement were elected members of the Finance Committee.

Griffith E. Abbot, George Wolf Holstein, Frank H. Rosengarten, John K. Valentine, James Huneker, Albert H. Smith, M.D., John A. Ryder, and Charlotte Uhlen Olsen, M.D., were elected members.

The following were elected Correspondents: John McCrady of Sewanee, Tenn., Charles T. Minot of Roslindale, Mass., Henry Hicks of London, J. W. Hulke of London, Thomas Belt of London, H. G. Seeley of London, W. T. Thistleton Dyer of London, Archibald Geikie of Edinburgh, James Geikie of Edinburgh, Charles Barrois of Lille, M. E. Jannettaz of Paris, Emil Sauvage of Paris, Ch. Velain of Paris, Edmond Pellat of Paris, H. Filhol of Paris, Michael Vacek of Vienna, and Karl von Seebach of Göttingen.

The following papers were ordered to be printed:—

NOTES ON THE NATURAL HISTORY OF FORT MACON, N. C., AND VICINITY. (No. 4.)

BY DR. ELLIOTT COUES AND DR. H. C. YARROW.

When the present series of papers was projected, it was intended that they should give a full account of the zoology of the locality, as studied by the writers during their successive residence at Fort Macon. Dr. Coues was Post-Surgeon at the Fort during 1869 and 1870, being succeeded in the winter of 1870-71 by Dr. Yarrow, who took up the work immediately and continued it until 1872.

Dr. Coues has already published two papers in these Proceedings (1871, pp. 12-49, and pp. 120-148), one on the Mammals, Birds, and Reptiles, the other on various Invertebrates, chiefly Mollusks. More recently, Dr. Yarrow has published (1877, pp. 203-218) a third paper, on the Fishes, giving the joint results of our respective collections—though it should be added that the observations are entirely those made by Dr. Yarrow, he having been furnished by Dr. Coues with simply a list of the species collected by the latter, as identified by Mr. F. W. Putnam, of Salem.

The present paper, No. 4 of the series, supplies many omissions in the first article, on the Mammals, Birds, and Reptiles—more particularly the latter. The series of papers may be completed by another communication, supplementing Dr. Coues's article on the Invertebrates (No. 2) with the results of Dr. Yarrow's more extended observations on several classes of the lower animals.

The writers are indebted to Prof. E. D. Cope, for identification of some of the Reptilia and Batrachia given in the present article.

I. MAMMALS.

***Ursus americanus*, Pall.**

Brown Bear

Common on the mainland near Fort Macon; and is also found abundantly in a large marshy piece of ground not far from Croatan, a station on the North Carolina Railroad. Numbers are taken during the fall and spring in large iron spring traps, their meat being for finding a ready market at New Berne, N. C. Some skins even show small patches of light grizzled fur resembling somewhat that occasionally seen in specimens of *U. americanus* from the Rocky Mountains.

Delphinus globiceps, Cuvier.

Black-fish. Round-head Grampus.

But a single specimen observed, this having been taken at a porpoise-fishing on Shackleford banks, six miles from Fort Macon. The fishermen stated that it was rarely seen or captured.

Vespertilio (Vesperugo) fuscus, P. de Beauv.

Brown Bat.

Does not occur abundantly, a few only being seen near wooded portions of Bogue banks.

Sciuropterus volucella (Pall.), Geoff.

Flying Squirrel.

This species is quite common in the woods in the southern extremity of Bogue banks, and is also found in similar localities on the mainland.

Tamias striatus (L.), Bd.

Chipmunk.

Very common on islands and mainland.

Mephitis mephitis (Shaw), Bd.

Common Skunk.

Not abundant on the islands, but extremely common on the adjoining mainland. No case heard of in this locality regarding the rabies which is occasioned by the bite of its western congener.

II. BIRDS.

***Melanerpes erythrocephalus* (L.), Sw.**

Red-headed Woodpecker.

Quite common in woods, especially at Harker's Island, eight miles northeast from Fort Macon. This island is also celebrated for the numbers of mocking birds found there.

***Antrostomus vociferus* (Wils.), Bp.**

Whippoorwill.

Occasional; but few seen.

***Coccyzus americanus* (L.), Bp.**

Yellow-billed Cuckoo.

Occasional.

***Cygnus americanus*, Sharpl.**

American Swan.

A single specimen was seen by Dr. Yarrow, Dec. 18, 1871, near Harker's Island, but the people of the vicinity state, the species is not uncommon. This individual was noticed swimming in the midst of an enormous "raft" of red-head ducks (*Fuligula ferina americana*).

***Fuligula vallisneria* (Wils.), Steph.**

Canvas-back Duck.

This species has been observed but once, four individuals having been noticed near Harker's Island, but we are informed it is quite common in the vicinity of Cape Lookout, fifteen miles from Fort Macon. The flesh, according to our informant, has not the richness of flavor which characterizes the Canvas-back of the Chesapeake.

***Oedemia fusca* (L.), Sw.**

Velvet Scoter.

Occasional, few having been observed.

***Mergus cucullatus*, L.**

Hooded Merganser.

Abundant in Bogue and Cove Sounds.

***Merula alle* (L.), V.**

Sea Dove

The occurrence of this species so far south is interesting. It is occasionally found on the beach after severe storms. The first specimen observed was secured in December, 1871, and others were subsequently taken. A number of the older residents of the

locality, to whom the specimens were shown, stated that they had never seen or heard of such a bird previously.

III. REPTILES.

TESTUDINATA.

Thalasseochelys caouana, Linn.

Loggerhead Turtle.

Extremely numerous; numbers are taken in peculiar nets set in Cove Sound.

Aspionectes ferox, Schw.

Soft shelled Snapper.

Tolerably common in fresh-water streams of mainland.

Chelydra serpentina, Linn.

Snapping Turtle.

Common in muddy creeks of mainland.

Cistudo clausa (Gmelin), Cope.

Box Turtle.

Common in woods of islands and mainland.

Although a number of other species of Testudinata were observed, none were collected or identified.

SAURIA.

Alligator mississippiensis, Gray.

Alligator

fifteen individuals over eight months in a common box, the bottom and sides being lined with green sods, the top covered with a pane of glass. These little reptiles became domesticated to such an extent as to feed from the hand when flies or ants were offered, and would also take a drop of water in the same manner. Unfortunately a scarcity of flies and ants necessitated a diet of grasshoppers, which produced diarrhœa, and all the specimens perished from this cause.

The natives of the "banks" have a great dread of these harmless and beautiful creatures, calling them "scorpions," and it requires considerable persuasion to induce them to touch one.

Their habits are somewhat peculiar, and were observed during their captivity with great care. In the act of copulation the male mounts the back of the female and entwines his tail with hers, and then seizes hold of the skin at the back of her neck; in this position they will remain for hours, apparently asleep, and in awakening resume the procreative act. During the day they are of a vivid green color, but as night or darkness approaches, they lose the bright green color, which becomes a rusty-brown, this change taking place gradually in spots and patches. This loss of bright color is also produced by cloudy weather. This species fights fiercely with *Cnemidophorus 6-lineatus*, and invariably conquers even with opponents of twice their size. Under the influence of anger the under part of the neck is puffed out, and the green color is then extremely bright. They shed their skins frequently during confinement, and cease taking food during this period, but, unlike the serpent, while undergoing this process, their eyesight is not affected. In one individual, who had suffered the loss of a portion of his tail—a full inch and a half—it was replaced by new growth within six months.

Oligosoma laterale, Say.

Ground Lizard.

Common, both on island and mainland. Generally appears towards evening.

Eumeces fasciatus, Linn.

Blue-tailed Lizard.

Occasionally met with in wooded portions of Bogue banks.

OPHIDIA.

Candisoma miliaria, Linn.

Spotted Rattler. Ground Rattlesnake.

A few individuals of this species are said to have been seen on Bogue banks, none, however, observed or secured by the writers, but they are quite common on Shackleford banks, a few miles from Fort Macon. It has also been taken on the mainland. It is a fact worthy of remark, that, while on Bogue banks, rattlesnakes and moccasins are extremely abundant, this is the only venomous species found on the neighboring island of Shackleford.

Ancistrodon piscivorus, Lac.

Water Moccasin.

Very numerous in woods of Bogue banks and on the mainland near wet and marshy places. Several specimens of enormous size secured. They are deemed so formidable by the residents, that, during the warm months of the year, no inducement will cause a visit to certain localities where these reptiles "use." In this connection it may be mentioned that Dr. Yarrow was informed by several individuals, that both moccasins and rattlesnakes had been seen a number of times swimming from the mainland to Bogue Island.

Ophibolus getulus sayi, Holbrook.

King Snake. Corn Snake. Thunder Snake.

Very common on islands and on mainland. This serpent is

him. In captivity they are very gentle, and it requires very severe provocation to induce one to bite. Several specimens which were kept in a large box could not be induced to eat either mice, frogs, or toads, but as several fine specimens of *Ophiosaurus ventralis* (Daud.), kept in the same box, soon disappeared, it was easy to account for the apparent want of appetite. In fact, a large male was found in the act of devouring one of the "glass snakes." It is believed that other species of *Ophiboli*, such as *O. doliatus* and *triangulus*, live upon the islands as well as the mainland, but none have been noticed.

Cyclophis vernalis, De Kay.

Green Snake.

This species is very common on the islands and mainland, and according to the writers' experience is, contrary to the generally accepted statement, extremely irritable in captivity, biting fiercely if disturbed.

Coluber quadrivittatus, Holbrook.

Chicken-snake.

Very numerous in woods of islands and mainland.

Coluber guttatus, Linn.

Spotted Racer.

Same remarks apply as to the preceding species.

Heterodon platyrhinus, Latr.

Sand Viper. Hog-nose Snake. Puff Adder. Blowing Adder.

Uncommon on islands, a single specimen only having been captured on Bogue banks, Nov. 1871. Thought to be poisonous by residents.

Dromicus flavilatus, Cope.

This new and interesting species was discovered by Dr. H. C. Yarrow, in the month of Nov. 1871, on Bogue banks some eight miles south of Fort Macon, near marshy ground; and a second individual was seen some months later at the same place, but was not captured, as it escaped into the water. The specimen was forwarded alive to Prof. E. D. Cope, who at once declared it new to science, and described it in the Proceedings of the Academy of Natural Sciences of Phila. for 1871, p. 223. At this time some doubts were expressed as to whether a second specimen would ever be secured, but the diagnosis of this eminent herpetologist has lately been confirmed by the discovery and capture of another

specimen by Mrs. A. D. Lungren, of Volusia, Florida, as recorded in *Am. Nat.*, Sept. 1877, p. 565.

IV. BATRACHIA.

Rana temporaria sylvatica (Linn.), Lac. .

Wood Frog.

Uncommon, but few having been seen on islands; more frequently met with on mainland.

Hyla versicolor, Le Conte.

Tree Frog or Toad.

Very common on islands and mainland.

Scaphiopus holbrooki, Harlan.

Solitary Spade Foot.

A single specimen only seen in woods of Bogue banks, but it is doubtless found in the mainland. Its nocturnal habits may account for its apparent scarcity.

Plethodon cinereus erythronotus (Green), Cope.

Red-backed Salamander. Mud-puppy.

Common. Residents fear it, as they do most of the lizards and salamanders.

Amphiuma means, Linn.

Mud Snake. Congo-snake.

This species occurs, without doubt, but it has not been noticed

**DESCRIPTIONS OF NEW SPECIES OF INVERTEBRATE FOSSILS FROM
THE CARBONIFEROUS AND UPPER SILURIAN ROCKS OF ILLINOIS
AND INDIANA.**

BY C. A. WHITE, M.D.

The fossils herein described are a part of an important collection that has been sent to me for study by Mr. William Gurley, of Danville, Illinois, at which locality a large part of the collection was made. Others were obtained by him, and by Mr. William Gibson, from well-known localities, and some new ones, in both the States mentioned in the title. The frequent discovery of new forms and interesting types in districts, the fossils of which have been studied by so many able paleontologists, shows the extraordinary profusion and variety of invertebrate life during paleozoic time, in that great region of which the States of Illinois and Indiana now form a part. Collections of this kind also suggest many important questions to the philosophical paleontologist, which, however, it is not the purpose of the author to discuss in the present paper.

RADIATA.

ACTINOZOA.

Genus **BARYPHYLLUM**, Edwards and Haime.

Baryphyllum fungulus, White.

Coralium depressed, discoid; inferior surface plain, or slightly concave, the principal, as well as some of the secondary septa appearing through the obscurely developed epitheca; periphery moderately sharp, upper or calycular surface gently convex; septal fossett only slightly developed; septa numerous but distinct; the principal septum opposite the septal fossett much stronger than any of the others; the other primary and secondary septa both of about equal strength, sharp upon their edges and slightly sinuous and irregular in their course. The irregular disposition of the secondary septa, peculiar to the genus *Baryphyllum*, is well-marked in this species.

Diameter, 10 mm.; height, $2\frac{1}{2}$ mm.

Only a single example of this species has been discovered,

slight imperfections of which obscure the centre of the under surface and also, in part, the septal fossett.

This species differs conspicuously from *B. Verneuilianum*, Edwards and Haime, the species upon which the genus was founded, and which was obtained from the Devonian of Perry County, Tennessee (see Monog. Polypiers Fossiles des Terr. Paleozoïques), in the much greater number of secondary septa as well as in other details.

Position and locality. Shales of the age of the Niagara Group, township of Waldron, Shelby County, Indiana.

ECHINODERMATA.

Genus **PLATYCRINUS**, Miller.

Platycrinus Bonocensis, White.

Body of the ordinary cup-shape, moderately deep; base shallow basin-shaped, concave at the middle of the under side, or appearing to be so in consequence of the presence of a moderately broad and strong circular ridge surrounding the central portion, and not extending outward quite to the borders of the base. First radial pieces about as long as wide, having the shape and characteristics of outline usual in cup-shaped bodies of this genus, scarcely more convex than the general convexity of the body; facet for the articulation of the second radial pieces shallow; second radial

With the arms thus folded the whole animal had an obovate form. The stem, near the body, is moderately strong, and slightly elliptical in outline of transverse section. Surface nearly smooth, or faintly corrugated. The part of the body above the calyx unknown.

Height of body to the top of the first radials, 8 mm.; greatest breadth, 10 mm.; height from the base of the body to the top of the arms, 26 mm.

This species resembles *P. æqualis*, Hall, as figured by Meek and Worthen in Volume V. of the Illinois Geological Reports; but it differs from that species in having the base concave instead of protuberant, in the proportions of the body, the comparative shortness of the arms, and in wanting the peculiar geniculation of the pieces of the double series composing the arms. It resembles *P. lævis*, Miller, as figured by de Koninck and le Hon on plate VI. Recherches sur les Crinoïdes du Terraine Carbonifère de la Belgique, but it differs in having only two, instead of three primary radial pieces to each ray, and also in other details of structure.

Position and locality. Subcarboniferous limestone, probably equivalent with the Keokuk limestone, Bono, Lawrence County, Indiana.

Genus **SCAPHIOCRINUS**, Hall.

Scaphiocrinus Gibsoni, White.

Body of medium size, or comparatively small; calyx roughly cup-shaped; plates moderately thick and protuberant, especially the radials and the first anal; base small, nearly or quite covered by the upper joint of the column; subradial plates comparatively large, tumid; first radials broader, but scarcely larger than the subradials; sutures between the plates of the calyx impressed, especially at the points where the angles meet, and where there is a pit-like depression which increases the tumid appearance of the plates, and gives the calyx a somewhat shrivelled aspect; anal space comparatively large. The postero-lateral rays consist of three pieces, including the first radials, and upon each of the third radials the first bifurcation takes place, and above this the posterior secondary branch only bifurcates, and this third bifurcation takes place on the eighth piece above the second bifurcation; giving five arms for each of the postero-lateral rays, beyond all

the bifurcations. All the pieces of the rays, including those of both the primary and subordinate divisions, have a tendency to become angular upon the back, especially at the upper side. This, together with the apparent corrugation of the calyx and the zig-zag articulation of the joints of the arms near their upper ends, gives the whole specimen a good degree of asperity of aspect. Pinules strong and somewhat angular, one arising from each joint of the arms and subordinate divisions of the rays, upon alternate sides. The other rays are not fully known, but they apparently bifurcate in nearly the same manner as the postero-lateral ones. Column moderately large, composed of irregularly alternating larger and smaller pieces. The whole surface of body, arms, and column distinctly granular.

Breadth of body. 7 mm.; height from base to top of first radial pieces, 4 mm.; height from base of body to the top of the arms, 35 mm.

This species resembles *S. æqualis*, Hall, as figured in Vol. V. of the Illinois Geological Survey, more nearly than any other known to me, but it differs from that species in the much greater proportionate length of the arms, as well as their number, and the manner of their bifurcation, besides the difference in the character of the surface. A conspicuous difference is seen in the divisions of the rays; *S. æqualis* having eight arms by the ultimate division of each postero-lateral ray, while the species under discussion has



last joint of the column; subradial and first anal plates as large as, or a little larger than, the first radials; the anterior, and the two antero-lateral rays only are known. These rays consist of three pieces each, including the first radials, already mentioned as a part of the calyx, and upon the third one the first bifurcation takes place, each division being once more bifurcated at varying distances from the first. In the anterior ray the second bifurcation takes place upon the eleventh piece from the first. In the antero-lateral rays, the second bifurcation takes place upon the ninth piece of the anterior branch of each of those rays from the first bifurcation, and upon the seventh piece, of the posterior branch. Near the tips of some of the arms there is still another bifurcation, the divisions of which being small, may easily be overlooked, or confounded with the coarse pinules. The pinules are large, long, and angular, each piece of all the divisions of the arms above the first bifurcation of the rays bearing one, which are arranged upon alternate sides. The backs of all the divisions of the rays are rounded, and have little or no tendency to become angular, except perhaps toward the extremity of the arms.

Column composed of irregularly alternating larger and smaller pieces. Surface granular.

Height of body from base to the top of the first radials, 3 mm.; width at top of the first radials, 4 mm.; height from base to top of arms, 28 mm.

The calyx of this species closely resembles that of *S. Gibsoni*, especially in the tumidity of the subradial and first anal pieces, and in the character of the column; but it differs very materially from that species in the number of arms and the character of their bifurcations, as well as in the surface markings and other details.

The specific name is given in honor of Mr. William Gurley, its discoverer.

Position and locality. Subcarboniferous strata, probably equivalent with the Keokuk limestone, Crawfordsville, Illinois.

Genus **LEPIDESTHES**, Meek and Worthen.

Lepidesthes Colletti. White.

General form apparently ovate. Interambulacral areas very narrow, linear, slightly convex from side to side, composed of four or five rows of small plates, which rows apparently do not decrease in number, except, perhaps, at either extremity. Ambu-

lacrals broad, partaking of the convexity of the body, lance-oval in outline, and five or six times as broad as the interambulacral areas are. Ambulacral areas made up of very numerous small rhombic plates, the transverse diameter of which is a little greater than the vertical; their lateral angles moderately acute, and interlocking so that they appear to be arranged in oblique rows; size of the plates nearly uniform throughout the field, except that they all become a little smaller near both the upper and lower extremities of the body. The number of vertical rows of these plates in each field is apparently 18 or 20. Each ambulacral plate has two distinct round pores near each other and near the upper angle of the plate. Surface granules small, more distinct upon the interambulacral than upon the ambulacral plates.

Only one specimen of this species has been discovered, and this is in a crushed condition. The original height was about 45 millimetres, and its transverse diameter probably considerably less.

The crushed condition of the specimen causes some doubt as to the true number of longitudinal rows of interambulacral plates, but they evidently do not exceed five. There seems to be only four rows to each area, one row of comparatively large plates, with two rows of smaller ones on the right-hand side of it and one row on the left. This want of bilateral symmetry suggests the possibility that one row on the left-hand side of the row of large plates has been forced beneath the others by pressure, but a

MOLLUSCA.

POLYZOA.

Genus **PTILODYCTIA**, Lonsdale.***Ptilodyctia triangulata***, White.

Corallum apparently ramose, transverse section triangular, the three sides being either flat or concave, usually the latter, and poriferous; the three edges sharp; the laminar axis consisting of three divisions which end respectively at the three edges, and meet at the centre of the corallum; pores well developed, but not arranged in the regular order that is common in this genus, nor are they bounded by any longitudinal or transverse lines or ridges.

Their mouths are moderately prominent, slightly oval, the direction of the longer diameter subject to no regularity. The breadth of the sides of the corallum varies from 3 to 5 millimetres; full length unknown.

This species differs from typical forms of *Ptilodyctia*, in having three flat or concave sides instead of two convex ones; in the axis being consequently tripartite, and in the irregular disposition of the pores upon the surface.

Position and locality. Coal-measure strata, Danville, Illinois.

CONCHIFERA.

Genus **ASTARTELLA**, Hall.***Astartella Gurleyi***, White.

Shell small, not very gibbous, subtetrahedral in outline; anterior end truncated from the beaks obliquely downward and forward to about mid-height of the shell, where the front is sharply rounded to the somewhat broadly rounded base; posterior border broadly convex, and joining both the basal and dorsal margins by more abrupt curves; dorsal margin comparatively short, nearly straight; beaks small, umbones not elevated nor very prominent. An indistinctly defined umbonal ridge extends from each of the umbones to the postero-basal margin, behind which the shell is slightly compressed. Surface marked by concentric furrows, which are separated by sharp linear ridges.

Length of an example of average size among those of the collection, 7 millimetres; height from base to beaks $4\frac{1}{2}$ millimetres.

This species differs from *A. vera*, Hall, with which it is sometimes associated, in its smaller size, in the slight prominence and want of elevation of the umbones, the greater proportional projection of the front beyond the beaks, and in being wider behind than in front, the reverse being the case with *A. vera*. The specific name is given in honor of Mr. William Gurley, in whose collection only I have seen the species.

Position and locality. Coal-measure strata, Danville, Illinois.

Genus NAUTILUS, Breynius.

Nautilus Danvillensis, White.

Shell moderately large, umbilicus deep, but not very broad, showing all the volutions; volutions apparently four, increasing rapidly in size, very slightly embracing, subtriangular in cross section, the two sides of the volution forming two sides of that outline, while the inner side of the volution forms its third side; sides of the volution plain, nearly flat or slightly convex; dorsum very narrow, concave, and marked at either edge, where it joins the side, by a row of longitudinally compressed nodes. The sides are rounded abruptly into the umbilicus, which is unusually deepened by the diameter of the volutions being greater at the inner side than elsewhere. Septa plain, somewhat deeply concave dorso-ventrally, but less so transversely; siphuncle subcentral, a little nearer to the dorsal than the ventral side. Surface smooth, ex-

est diameter being adjacent to the umbilicus, are characters that distinguish this species from all others known to me.

Position and locality. Coal-measure strata, Danville, Illinois.

. ARTICULATA.

VERMES.

Genus **SERPULA**, Linnæus.

Serpula Insita, White.

Permeating an earthy carbonaceous layer of the coal-measure strata at Newport, Vermilion County, Indiana, are abundant fragments of a very small serpula, which evidently burrowed in the mass when it was in the condition of mud. Also sessile upon the surface of some embedded shells are some nearly perfect examples of the same species. The species of this genus are usually so devoid of characteristics that clearly separate them from each other, that a distinctive diagnosis is difficult or impossible. This species is not likely to be mistaken for any other, in consequence of its very small size, and because no other is known in the rocks of that age in that region. It is named for the convenience of fully classifying all the collections of fossils which are yielded by the rich strata of the coal-measures of Illinois and Indiana, as well as the adjoining States. This species may be characterized as minute, sessile or free, tortuous, subcylindrical.

FEBRUARY 5, 1878.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-two persons present.

The deaths of Andrew Murray, a correspondent, and of Dr. Chas. L. Cassin, U. S. N., a member of the Academy, were announced.

Note on Calycanthus Floridus.—Mr. THOMAS MEEHAN said, though this plant has been under culture for many years, the fruit was rarely seen. In correspondence with a leading author, it had been suggested that the plant might be incapable of self-fertilization, and that, being so far from its native place, the special insect arranged to be the agent in fertilization had not followed it. Since that time Mr. Meehan had obtained seeds from the Cumberland Mountains in Tennessee, and plants from these had flowered on his grounds, many of them producing fruit in the greatest abundance, while the old plants still remained as barren as they ever were. It was therefore clearly a case in which insects had no agency one way or the other. There was, he said, in plants two distinct forms of force—the vegetative and the reproductive; the one growing out of and dependent on the other, and yet to a certain extent antagonistic; and that these forces had their lines especially in the petaloid and staminoid verticils, and this resulted in producing some individual plants abundantly productive of fruit, while others were almost or wholly barren.

Distinctive Characters of Teeth.—Dr. HARRISON ALLEN proposed to distinguish the buccal from the palatal side of human upper molars by the presence of a sulcus upon the latter surfaces and its absence from the former. The bicuspid teeth were found to present crowns having an anterior and posterior limiting ridge upon their grinding surfaces. These ridges are inconstant in the molars, notably upon the posterior edges of their crowns. Upon the anterior edges they, as a rule, are seen, and recall the peculiarity of the similar teeth of *Cynocephalus* and *Semnopithecus*. When a human molar exhibits the antero-palatal cusp united to the antero-buccal cusp by a well-pronounced limiting ridge it was thought to be an instance of reversion of the human to the quadrumanous type.

FEBRUARY 12.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-one persons present.

The following papers were presented for publication:—

“Notes on North American Caridea in the Museum of the Peabody Academy of Sciences at Salem, Mass.” By J. S. Kingsley.

“Additions to Mr. Cooke’s paper on the Valsei of the United States.” By W. C. Stevenson, Jr.

The deaths of George T. Barker, Thomas P. Remington, and Wm. Welsh, members of the Academy, were announced.

FEBRUARY 19.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-three persons present.

Foliaceous sepals in Hepatica.—Mr. MARTINDALE exhibited a specimen of *Hepatica triloba* which he had collected near the mouth of the Wissahickon Creek, in April, 1877, all the flower stalks of which had produced leaves in the place of sepals similar in shape to those usually produced on the leaf stalks, but only about one-half their size; and then spoke of the causes of this change of condition. He stated that investigators in the study of this branch of the vegetable kingdom had long since attributed any deviation from the normal character as due, not to a want of vitality, but to a superabundance of vitality, and claimed that this specimen was a fair illustration, and a confirmation of that theory, it being the largest specimen he had ever seen. The great

abundance of roots, the presence of a large number of leaves of the preceding year, which had remained attached to the plant throughout the winter, the true leaves of the season just becoming visible, and which appeared to be of greater abundance than those of a former year's growth, all gave evidence of the presence of an unusual amount of vitality. No flowers had been produced 'at all, at the same time the flower stalks which had produced leaves were exceedingly numerous. This morphologic change gave evidence of still another: as these leaves upon close examination were found to be covered with a fungoid growth of a low type, the tendency of which may have been to dwarf or disturb the full and free exercise of the vital force of the plant.

Mr. THOMAS MEEHAN observed that he was not prepared to say that extra vigorous growth in a plant had any relation to morphological changes in the parts of the inflorescence, but he regarded with great interest the specimen exhibited, because he believed the normal change of leaves to sepals would not have been interfered with but for the presence of the minute fungus. As in the cases which he had in the past brought to the notice of the Academy, where *Euphorbia prostrata* and *Portulaca oleracea* became erect when attacked by an *Æcidium*, he thought the present an illustration that varying phases of nutrition governed form. We know from many observations that interference with nutrition had an influence on morphological changes. The calla (*Richardia Æthiopica*) which under one system of culture produced all leaves, under others had some of them changed to its white spathaceous flowers, and a ringed branch would often cause what would otherwise have been leaves and branches to

Some authorities refer to citrine as probably being produced by burning amethyst or smoky-quartz (*Kluge: Handb. Edelsteinkunde*, 374; *Lange: Halbedelsteine*, 30). Prof. Leidy exhibited clear, colorless specimens of quartz, cut and in the natural crystal, which he said were amethysts and smoky-quartz, which had been submitted for a short time to a moderate red heat, resulting in the total expulsion of all color. Smoky-quartz of the darkest hue, from Paris, Maine; Hot Springs, Arkansas; and Pike's Peak, Colorado, have the color completely dissipated after a short exposure to moderate red heat. Perhaps heating under peculiar circumstances may convert the usual color of amethyst into the yellow of the citrine, but specimens heated in the ordinary manner did not indicate such a change.

FEBRUARY 26.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-two persons present.

The deaths of Prof. Andreas Retzius and of Dr. O. A. L. Mörch, correspondents, were announced.

Papers entitled "Distribution of Spiders by the Trade Winds," and "The Basilica Spider (*Epeira basilica*)," by the Rev. H. C. McCook, were presented for publication.

J. Gozzardini, Bologna; G. Meneghini, Pisa; Antoine Stoppani, Milan; Francisco Coello, Madrid; J. J. Steenstrup, Copenhagen; F. Steenstrup, Copenhagen; R. Brough Smyth, Melbourne; Edouard Van Beneden, Liege; and Jules Künckel d'Herculais, Paris, were elected Correspondents.

The following papers were ordered to be printed:—

ON THE ALKALI OF THE PLAINS IN BRIDGER VALLEY, WYOMING
TERRITORY.

BY E. GOLDSMITH.

Whilst visiting Fort Bridger, Wyoming, Prof. Leidy observed on the plains in the vicinity an efflorescent salt, called there alkali. It appears as a dirty-gray powder; amorphous not only to the naked eye, but also beneath the microscope.

The flame reaction shows the presence of soda and potassa. Heated in the closed tube it blackens and emits some water having an alkaline reaction. Water dissolves part of it, and leaves a dark-colored residue. In the watery solution I recognized lime, potassa, soda, sulphuric acid, and a trace of chlorine and ammonia. The insoluble part consists of silica, colored by oxide of iron.

After two grammes were perfectly exhausted with distilled water, the water expelled and the remaining mixture of salts dried on steam, I obtained 0.551 gramme = 27.55 per cent.; the insoluble part is the difference, or = 72.45 per cent.

Upon separating the lime, and changing the sulphates of potassa and soda into their respective chlorides, I obtained a dry mixture of 0.448 gramme of chlorides, from which was extracted 0.08389 gramme of chloride of potassium; hence, by subtracting 0.36411 gramme of chloride of sodium and computing these chlorides into

are formed on one side, similar to cauliflower; no crystalline particles are seen by ordinary inspection. Beneath the microscope, however, a few prismatic crystals were observed.

The flame reaction indicated soda and potassa.

Heated in the tube, closed at one end, it changes to black, showing that the substance contains some organic matter; it also gives water.

If heated on coal before the blowpipe, it is all absorbed.

In water, the substance is soluble, with the exception of a small quantity of flocculent matter, which seems to be silica.

The watery solution is alkaline to test-paper. The solution seems to contain no other bases than those named above, but partly combined with chlorine, partly as sulphates and carbonates. No attempt was made to determine the organic matter.

I found that 0.727 gramme lost on steamhead 0.006 gramme = 0.82 per cent. of water. 1.4035 gramme gave 1.2605 gramme sulphate baryta = 0.4327 gramme = 30.83 per cent. of sulphuric acid. 0.7445 gramme gave 0.5875 gramme of chloride of silver = 0.1452 gramme = 19.50 per cent. of chlorine. 1.000 gramme of the substance gave, after the sulphates had been converted into chlorides, 0.8865 gramme of a mixture of chloride of sodium and chloride of potassium, from which I separated 0.1948 gramme of chloride of potassium; hence $0.8865 - 0.1946 = 0.6919$ gramme of chloride of sodium.

From the data, the computation in regard to the affinities was carried out with the following results:—

Na Cl	. . .	32.14	per cent.	
Na S	. . .	36.21	" "	
Na C	. . .	6.52	" "	
K S	. . .	22.71	" "	
Si	. . .	0.21	" "	
H	. . .	0.82	" "	
Organic matter,	. . .	1.39	" "	by difference.
		<hr/>		
		100.00		

In the result of this analysis, it is demonstrated that four distinct alkaline salts are contained in the mixture in which the potassa sulphate is remarkable. From the small quantity of water found, I infer that the atmosphere must be extremely dry in that particular locality.

Two other mineral specimens from the same locality were obtained by Prof. Leidy. Both were of the same general character. They are uneven, rough, and formless. Throughout the mass small irregular holes are seen, which probably were produced by carbonic acid gas. Both specimens were analyzed and found to be of the same composition. They are impure carbonate of lime, containing some soda and potassa, and are colored by oxide of iron.

ON THE MECHANICAL GENESIS OF TOOTH-FORMS.

BY JNO. A. RYDER.

During a study of the osteology of the mammalia, the views herein advanced were first conceived as a rational explanation of the origin of the shapes of dental structures, as they exist in the different groups. More mature deliberation has only served to strengthen the conviction that the inquiry is in the right direction, since no body of facts with which I am acquainted are more beautifully and intimately interrelated than those which I have here so imperfectly presented. It is hoped that a better appreciation of what might, without violence to commonly received ideas, be called evolutionary teleology, may be attained by pursuit of similar inquiries in other directions.¹ This attempt to unravel a portion of the complex interrelations of the parts of organic beings, so as to show how their metamorphoses may be effected by mechanical means, it is believed, may not strike the mind of the reader as altogether futile, nor the title as quite so presumptuous, as would at first appear, after all the facts have been weighed. The interpretation of the rationale of the differentiation of structures in a mechanical way is not entirely new, since Lamarck, in his "Philosophie Zoologique" (1809), and latterly Mr. Spencer, with greater philosophical grasp, have both shown that efforts exerted to overcome resistances are retroactive and induce modifications in the parts of organisms.²

Ann. Naturalist, 1877, p. 603. Nature, vol. 17, 1877, p. 128.

¹ It may be observed here that the nomenclature of tooth-forms adopted throughout is that proposed by Prof. E. D. Cope in his memoir, entitled "On the Homologies and Origin of the Types of Molar Teeth of Mammalia" (Philadelphia Journ. Acad. Nat. Sci., Philada. 1874). The names are not intended as characterizing groups or orders in the system, but rather as designating distinct classes of teeth, which may exist in the same or even the same form in several distinct orders or families of the class. The definitions of terms remain the same, except those of the words *isognathous* and *heterognathous*, which I use so as not only to indicate respectively parity and disparity in transverse diameter of the crowns of the upper and lower molars, but also the parity or disparity in width transversely, from inside to outside, over both maxillaries, including the bony palate and the width across both rami of the submaxillary. This additional signification

Tooth-forms and Jaw-movements of the Groups.—It may be stated in general terms that the primates are bunodont and relatively isognathous, consequently the lateral movement is limited. This type of dentition is affirmed to be generalized, or, in other words, to be present in several diverse groups; first occurring in earlier forms and in the young of many, previous to or during the protrusion of the teeth from the gum, prior to or about the time they become functional. Man is usually not perfectly isognathous, the nearest approaches to it that I have observed were in the skulls of a Slavonian and an Anglo-Saxon. *Cynopithecus* and *Macacus* are anisognathous, and the South American howler monkeys and marmosets even more so. The American primates seem to present the anisognathous extreme, and the Old World forms the isognathous. Another fact of interest here is the shape of the glenoid cavity. In the gorilla it is more like man's than in any primate I have examined; deeply excavated transversely, with a prominent transverse ridge bordering the excavation anteriorly. This form of glenoid cavity entirely disappears in the howlers, in which it is a comparatively plane surface; the superior surface also of the condyle is flattened and expanded transversely, as in selenodont ungulates, which agrees with the presence of the rudimentary crescentic cusps and the anisognathism. The chimpanzee has a relatively plane glenoid surface, and in man the depth of the excavation of the cavity is greater even in the Aus-

jaw in sliding sidewise pass through the same distance. A few of the group retain the simple haplodont type of tooth, *e. g.*, *Rosmarus*.

The passage from the archetypal bunodont tooth to the scissors-like (carnassial) sectorial arrangement is plainly exhibited, by selecting a series beginning with *Ursidæ*, and continuing with *Amphicyon*, *Procyonidæ*, *Melinæ*, *Cercoleptes*, *Mustelidæ*, etc., and ending with the *Felidæ*, as the extreme of specialization.

Amongst the *Ungulata*, the most conclusive evidence is found in confirmation of the law of dental modification here enunciated. The numerous living and extinct species present a remarkable chain of dental forms, gradually departing from the bunodont type, and passing into the excessively modified selenodont, accompanied with increased mobility of the mandible in a lateral direction and increased anisognathism.

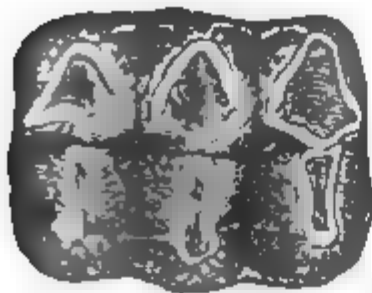
The *Toxodontia* present a ptychodont type of dentition, are very anisognathous, and the condyles approach in form those of the selenodont ungulates; they in all probability moved their jaws laterally. The enamel patterns are reversed in opposite series.

The Hyracoidean dentition is tapirodont, with an apparent tendency towards the selenodont, anisognathous with condyles transversely expanded, which may be regarded in connection with the truncate crowns of the molars and plane condyles as evidence of extensive lateral movement.

The *Proboscidea* are regarded as trichecodont, a careful examination, however, reveals that the inner tubercles above and the

outer ones of the inferior molars of some of the extinct forms (*Trilophodon* and *Tetralophodon*) were slightly selenodont (Fig. 1), anisognathous; molars tuberculate, in few cross crests; condyles more like that of selenodont ungulates, with lateral motion. In *Elephas* and *Lorodon* the jaw-movement is from behind forwards; condyles more rodent-like, isognathous; molars with flat crowns; tubercles becoming obsolete from wear, and blended into numerous transverse plates.

Fig. 1.



Slight upper molar of *Mastodon*.

The *Sirenia* are trichecodont and bunodont. The trichecodont form (*Manatus*) seems to have some lateral motion, as there is

some degree of anisognathism. The teeth of the Dugong when young are bunodont, as is shown by a specimen in the collection of the Academy.

The toothed cetaceans have a type of dentition more or less nearly haplodont (*Zeuglodon* presents two rooted molars and premolars, with a simple, compressed serrated crown).

The *Mysticete* are without true teeth, jaws greatly modified, rami separate, keratose laminæ (baleen) and surrounding soft parts acting as a prehensile apparatus in connection with the movement of the creature through the water.

In the insectivorous group *Chiroptera*¹ the dentition approaches, in some respects, that designated as symborodont. It is anisognathous, but differs in the bats from the symborodont greatly in the manner in which the teeth of opposite series fit into each other; it is also met with in nearly as marked a form in some marsupials (*Didelphys*), and in *Insectivora* (*Talpidae*, etc.). The anterior V-like cusp of the inferior molar series is longer than the posterior, the former fits into an acute or triangular space partially separating the upper molars on the inside, the latter fits

¹ The following tables are of interest as exhibiting a gradual reduction of molars and premolars in this group. They are taken from an abstract of an elaborate paper by W. Leche in *Weigmann's Archiv f. Naturges.* xliii., Pt. 5, 1877, 353. I have not seen the original in *Lund's Universitets Årsskrift*, tome xii., 1876.



into a similar space or groove, between the V-like cusps of the upper molars. The condyles are elongated transversely and somewhat ginglymoid in respect to articulation, and do not admit of much lateral movement.

The foregoing remarks render further notice of the dentition of *Insectivora* unnecessary, or see St. G. Mivart's papers.¹

Amongst Rodents a greater variety of dental forms is to be found than in any other order of the class with the exception of the marsupials; frequently haplodont, ptychodont, or bunodont, and, sometimes, even approaching the selenodont form. It is very likely that the very common opposite arrangement of the folds of enamel in the opposite series has had the same origin as those in the selenodont system. In many species the dentition is peculiar, and has no parallel in other orders. What is now referred to is the curious pattern met with in such genera as *Arvicola*, *Fiber*, and *Neotoma*, where the figure formed by the enamel covering of the triangular dentine columns stands reversed in respect to those of their fellows of the opposing series. The various grades of anisognathism and isognathism here find their fullest expression; indeed, the multiformity in this and other features is such as to be worthy of more extended study than can be devoted to them without a complete collection of jaws and teeth of recent and fossil species.

The dental system of *Bruta* is usually haplodont, though in the extinct *Hoplophoridae* and *Myodontidae*, it was ptychodont in form, but not in structure, since there was no enamel to be folded. In the former group (*Glyptodon*) the teeth were inclined forwards in the lower series, and backwards above, as observed in Arvicoline rodents, which with their form in section gives us a hint as to the origin of that form.

The marsupials, other than the insectivorous ones, present the trichecodont and a type simulating the selenodont in *Phascolomys*. A remarkable form is observed in *Stereognathus*, as described by Owen, where the crescentoid middle tubercles have the convex side directed backwards, and the concave forwards in the molars of the mandibles, which arrangement, as he observes, is not found in any other living or extinct species of mammal.

¹ Journ. of Anat. and Physiology, vol. i., 1867, pp. 280-312; Ib. vol. ii. pp. 117-154.

Differentiation of Dental Systems.—By what Professor Cope calls “synthesis of repetition,” the origin of the various types of mammalian dentition is rationally accounted for, by supposing an additional modicum of growth force as duplicating the primitive dental body, in lateral, longitudinal, or oblique directions. In all the ruminating ungulates the repetition of tubercular structures is now tending to take place on those sides of the teeth most subject to the severe impacts incident to mastication, as is shown by the appearance of rudimentary tubercles (cingules) upon the outside of the molar teeth in the mandible, and upon the inside in the molars of the maxillary. Another kind of differentiation has taken place in the incisors of the horse, as I have attempted to show in a previous paper,² where the duplication has taken place from the posterior side, in accordance with the generally prevalent acceleration going on in the whole dental system, and to account for which I cannot forbear suggesting that the severe wear to which these structures have been so long subject, together with the peculiarities of mandibular motion, have conspired to produce the following changes: the elongation of the teeth, their consequently deeper implantation in the mandible, and the fusion of the fangs or roots into the simple, persistently growing, rootless columns. This gradual elongation and fusion of the roots of the teeth is well seen in the series of horses’ teeth which Prof. Huxley presents in his third lecture in New York.

pared for assimilation, or was relatively soft as in the *Suina* and some rodents (*Sciurus* and *Mus*). In all rodents, the incisors grow from persistent pulps, no matter whether the molars grow from such pulps or not, showing again that strains have here played the part of directive agents, controlling growth force.

Methods of cusp duplication may be tabulated as follows:—

1. Interstitial ; developing connecting ridges (possibly this appearance is often due to compression of the cusps).
2. Lateral ; either palatal or buccal, internally above, and externally below (*Cervus*, *Bos*).
3. From behind ; by the successive addition from behind of transverse rows of cusps or greatly flattened and expanded single ones. As in *Mastodon*, *Elephas*, *Hydrochoerus*, and *Potamochoerus*.

Whilst such changes in cusp growth are going on, the external cementum layer thickens as modern and domesticated forms are approached ; the last (living) term in a given phylum of herbivorous ungulates usually having it thickest.

Prof. Harrison Allen's views on cusp duplication, as expressed in an article in the *Dental Cosmos*,¹ "On the Nomenclature of the [human] Teeth," are worthy of notice in this connection. His views, which are very clearly stated, may be summarized and somewhat expanded, so as to include other mammalia, as follows:—

1. That the cusps are the initial (embryological, and, therefore, palingenetic) elements of the teeth from which the fangs or roots are produced by the gradual thickening of the dentinal structures.

2. That the development of bicuspid (premolar), quadricuspid (molar) teeth is effected by the repetition of the unicuspid form (incisive or haplodont), i. e., by the functional development of Cingules,² or rudimentary cusplets at the base of the crowns of unicuspid, bicuspid, quadricuspid, etc, forms, often forming cingula, that are frequently broken up into small, more or less distinctly defined tubercles.

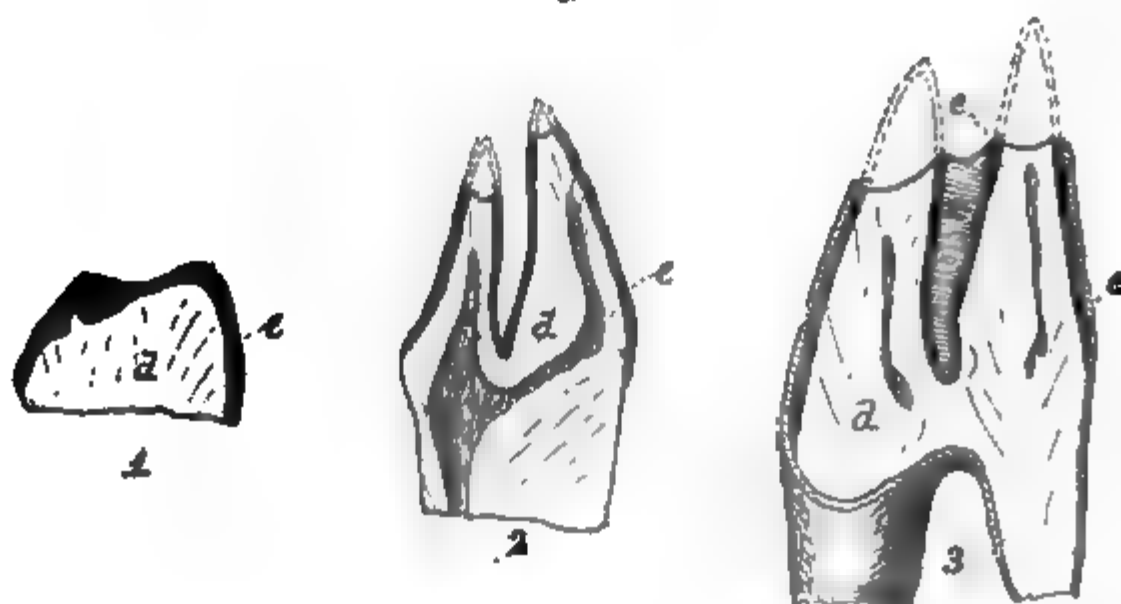
Several instances occur amongst the mammalian orders exhibiting greatly elongated cusps. In the cases of the Ungulates and Proboscidiens the steps of the process can be pretty easily traced. In the former the primary form is the simple cone, which gradu-

¹ Vol. xvi., 1874, pp. 617-623.

² A convenient term, proposed by Prof. Allen.

ally becomes more and more compressed, and at the same time produced (Fig. 2), the acute fore and aft edges of which are turned

Fig. 2.



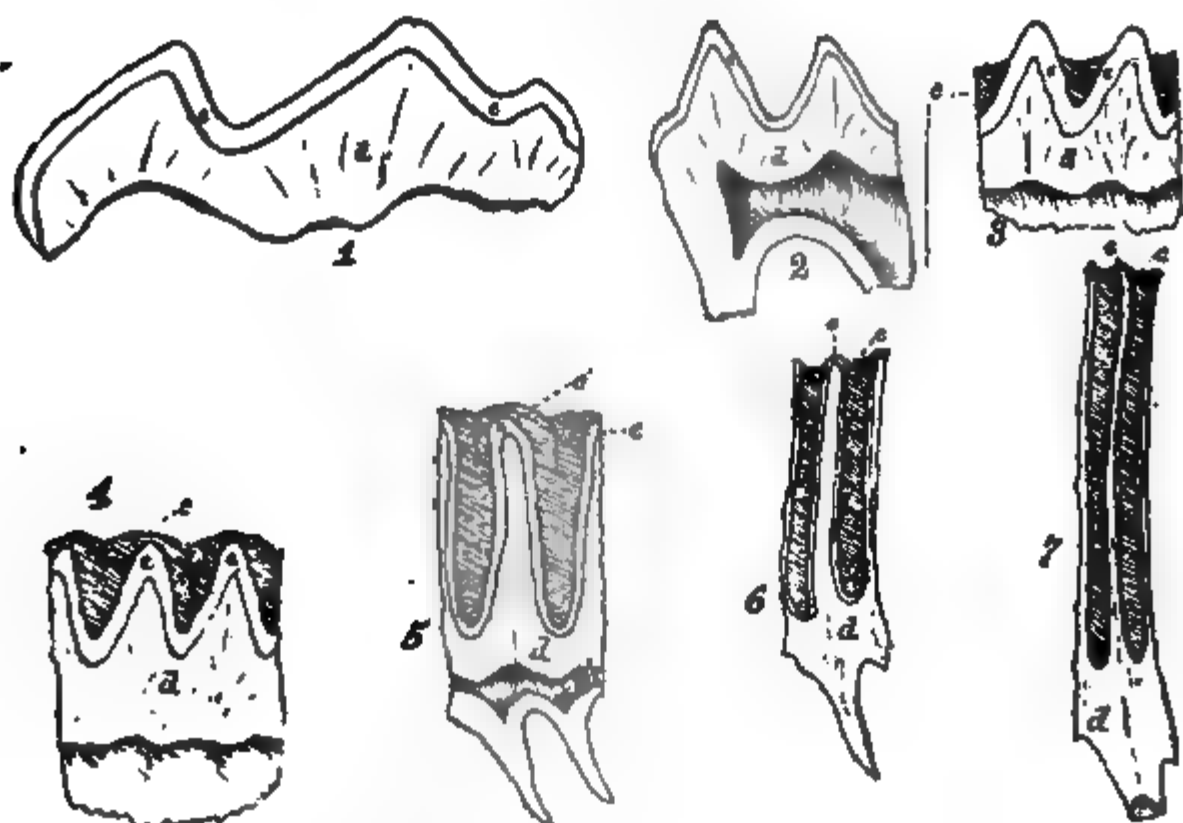
1. Transverse vertical section of rear upper molar of *Sus erymanthus*.
2. Same of *Trugocerus amulthensis*.
3. Same of *B. taurus* (Altered from Gandry). d, Dentine, e, enamel, and c, cementum. The dotted lines at the apices of the cusps of 2 and 3 show the portion worn away.

either outwards or inwards, as the teeth happen to be upper or lower molars, while as the apical portion of the cusp is worn off the characteristic crescentoid pattern becomes apparent.

In the Proboscidiæ we probably encounter a successional series of tooth forms in which the individual cusps were short and distinct, with little cementum in *Mastodon*, but as the surviving

selected and reduced from Plates I., II., and III. of Falconer and Cautley's *Fauna Antiqua Sivalensis*.

Fig. 3.



1. Longitudinal and vertical section of the crown of a lower molar of *Dinotherium magnum*.
2. Same of two cross-sections of an upper molar of *Mastodon ohioensis*.
3. Same of two cross-sections of a lower molar of *Elephas ganesa*.
4. Same of three cross-sections of *E. insignis*.
5. Same of a cross-section of *E. planifrons*.
6. Same of a lamellum or cross-section of *E. hyndricus*.
7. Same of *E. indicus*.
8. Dentine; *a*, enamel, and *c*, cementum.

As we have seen, the increase in mass and length of the food triturating organs (teeth) of herbivora have increased as we ascend through the successive geological horizons, have uniformly been broadened to present a more available crushing surface, and have, in many special cases, diverged from the ancestral type, apparently because certain strains operate in a way entirely new, owing to the necessary, voluntary, or intelligent assumption of new habits of life. I would add the following from unpublished MS. upon another subject: "When the various groups of terrestrial running birds and mammals, and also the saltatory, or leaping mammalia, are considered, the evident strengthening and modification of certain toes, resulting in their specialization and

reduction, is so apparent, that to deny the agency of strains as a very potent cause, is simply to ignore the plainest principles of physical development, where to accelerate that development, gradually increasing resistances must be overcome so as to acquire increased strength, as illustrated in the training of oarsmen, gymnasts, lifters, and pugilists. The peculiarities of muscular development, induced by peculiar strains incident to the pursuit of certain trades, is a further illustration."

As it is by the duplication of tubercles in various directions, their fusion, suppression, or atrophy, enlargement or hypertrophy, and total suppression, that the various types of teeth and dentition seem to have arisen, some of the causes of these changes may next be considered. But in order fully to appreciate the potency of such causes as may be suggested, it will be well to take a glance at some of the dental systems of the mammalia to see if there is any evidence of plasticity of the teeth. What favors the idea of plasticity more than anything else is the constant reversal of the forms of the tubercles in opposite molar series, as in Artiodactyls and Perissodactyls, the reversal of the plan of the foldings wherever the ptychodont type prevails, as in rodents and *Toxodontia*, as though forced into those shapes by some force always acting in a definite direction. The fact that the component cusps of the molars of almost all rodents and ruminants are, in the former, transversely, and, in the latter, longitudinally com-

the later type in a single generation, but entailing that slight change upon offspring through the law of heredity, and these two processes again indefinitely repeated until the sum total of perhaps infinitely slight differentiations effected in this way, amounts to the difference of form we note to-day between the ancient bunodont and modern selenodont.

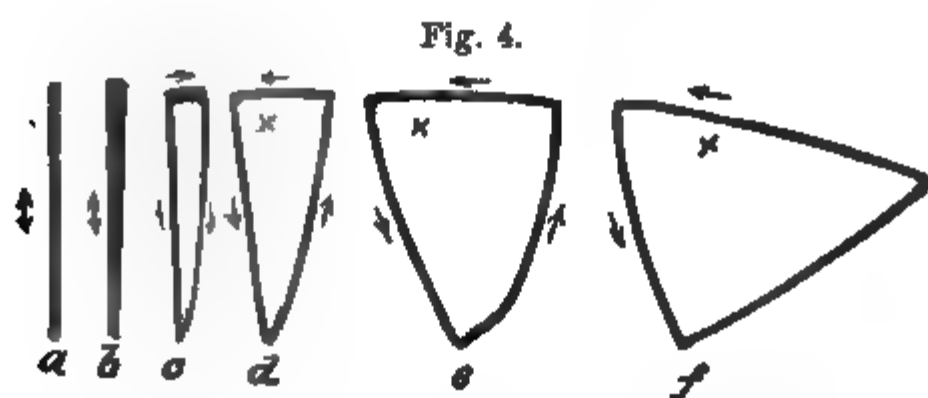
Zoologists, previous to this time, seem to have paid little or no regard to the mandibular movements of animals as the proximate causes of tooth modification. Although most of the reasoning in favor of such a view is of the *a posteriori* kind, there is not wanting in other facts of biology the obvious relation between cause and effect, which is here appreciable only as an effect, for which it is entirely warrantable to assume a cause discoverable, and capable of a rational interpretation. Indeed, until the appearance of the palæontological works of such pioneers as Owen, Leidy, Falconer, and others, it was scarcely possible that anything suggestive of a constantly active modifying force should have crossed the mind of the zoologist. It was from their work, in connection with some studies in recent osteology, that I was led to commence making observations upon the various living groups, as represented more particularly in the collection of the Philadelphia Zoological Society,¹ with especial reference to the kind of mandibular movement peculiar to the different orders, and I was not disappointed to find my surmises substantiated by the actions of the living animals. I observed that there were several distinct kinds of mandibular movement, each kind corresponding to some very distinct type of tooth, which led to the observance of other classes of facts, whose import, until then, I had not comprehended. I noticed, too, that in some cases the movements were different at different times in the same animal, and in some that the kind of movement during rumination was characteristic of a single species, as in the camel.² I also noticed that the lamas and vicuñas had peculiar movements, which seemed to be transition forms, imperfectly bridging the gap between that characteristic of the camel and the ordinary type of ruminants.

¹ I take this opportunity of making an acknowledgment for the facilities so kindly afforded to me for study by Mr. A. E. Brown, the Superintendent of this institution.

² This feature is as characteristic of the *Tylopoda* as the synchronous forward movement of both legs one side in walking.

In no case, however, did the movement depart from the kind characteristic of the species, family, or order, so as to invalidate any conclusions which might be drawn from them as conditioning changes in tooth-structure. Due allowance was also made for the different kind of food which, in special instances, the creatures under consideration were compelled to eat in confinement, due to removal from their native wilds.

The varieties of mandibular movement observed are diagrammatically shown in Fig. 4, which were obtained by selecting and



watching some point on the end of the mandible, or of the lower lip while the jaws were in motion, and the various figures which were thus described by the point chosen were found to be in various animals very nearly those marked *a*, *b*, *c*, *d*, *e*, and *f* in the diagram. The end of the mandible in carnivora was found to describe

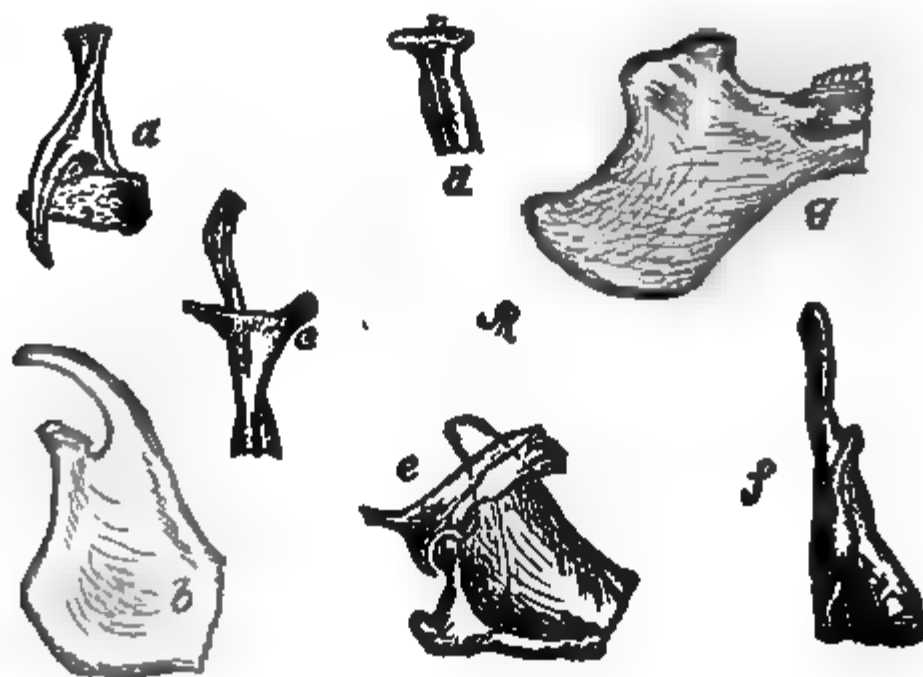
bunodonts or their immediate allies. The figure *b*, showing slight lateral movement, is that made by *Phacochærus*, which is one of the few pigs in which the teeth become worn perfectly plane on the crowns, the surface of which is at right angles with the vertical axis of the tooth. That at *c* is the figure described by the tip of the mandible of the Tapir while feeding on hay and fresh grass, showing that the texture of the aliment makes no change upon the jaw movement. Fig. 4, *c*, may also be regarded as typical, with slight modification (a little oblique), of the kangaroos and phalangers; the molar teeth of which, also, strongly remind one in some respects of those of the tapir. At *d* a theoretical form is shown, so as to fill the gap between *c* and *e*, and which, no doubt, was exhibited at some stage of the transition from *c* to *e*, *Anchitherium* might be suggested as a probable case. That at *e* is the figure observed in many species of both ruminants and non-ruminating creatures. Several of the *Cervidæ* and the rhinoceros were observed to describe this kind of a figure, and from its prevalence amongst ruminating animals, which I had the opportunity to notice, I suspect that it is the commonest form. The figure at *f* is that described by the giraffe, camel, and ox, in which the extreme in respect to the degree of lateral excursion is also reached.

In respect to the movement of other groups, such as the rodents, for instance, the movements were made with such rapidity that it was with great difficulty that the form of the figure described by some fixed point at the end of the mandible could be seen plainly enough in the absence of a more perfect recording apparatus than the eye of the observer. Enough was made out, however, to show that the motions were often similar to those in the ungulates; this was especially observed in the rabbits and guinea pigs, where an alternate movement of the mandible was made first towards one side and then towards the other, as in the camels. In *Geomys*, *Arvicola*, *Fiber*, and numerous other rodents, the motion of the mandibles when in contact, is believed to be from before backwards, on account of the direction of the flexure of the molars, and the absence of cross-crests on their crowns. In the elephants, however, it seems to be from behind forwards, just the reverse of that noticed amongst some of the rodentia with the absence of cross-crests, as in most of the latter.

It was this absence of cross-crests in the rodentia, together

with the isognathism of the modern elephants, and the presence of salient cross-crests, with a well-marked anisognathism in *Trilophodon*, *Tetralophodon*, *Stegodon*, and *Dinotherium*, that has led me to infer that the mandible was moved from side to side in these genera, just the reverse of what is the fact in the former.

Fig. 5.



a. Condyle and posterior portion of ramus of the mandible of Giraffe from above.

b. Same, external view.

c. Same, posterior view.

d. Same, small detail, inferior view.



great lateral excursion, during mastication, with selonodont molars, and a great degree of anisognathism. It must not be forgotten, however, that the type of condyle found to exist where the lateral movement of the mandible is not so extensive, is also less flattened and not so much elongated transversely, as will be seen in the Tapir (see Fig. 4, *c*, for diagram of the movement). In the rhinoceros (Fig. 4, *e*) the condyle is also less modified on account of the lesser lateral movement.

In the cats the characteristic cylindroid condyle (Fig. 5, *d*), and the processes that partially clasp it anteriorly and posteriorly, are shown in Fig. 5, *e*; again enforcing the relation subsisting between condylar structure and jaw movement, Fig. 4, *a*. Here again, as in the previous case, the structure is modified, as we pass from the most specialized carnivorous group, cats, to the less specialized dogs and seals, where the anterior and posterior processes from the anterior and posterior boundaries of the glenoid cavity are less salient. The idea has suggested itself to me from seeing the different modes in which the two groups, cats and seals, feed, that the differences in the structure of the mandibular articulation may have something to do with the manner in which they tear their food into pieces small enough to swallow. The cats hold the prey with the fore-feet, the incisor and canine teeth are fastened upon some part, while the paws, with the aid of the retractile claws, hold the prey securely down; the head is then raised and thrown back, and in this way the tough ligaments, tendons, integuments, and muscles are torn apart into pieces sufficiently small to be further acted upon by the molars and swallowed. The seals, on the other hand, fasten the teeth upon their prey (if a fish, always head first), and with sudden lurches of the head and body sidewise, with surprising velocity, the fish is torn in two by means of the suddenness of the movement, the free end being thrown several feet away, which is, however, very soon recovered, and, if too large to swallow whole, is treated as before. Now in the first case the strain incident to pulling back the head by a number of powerful muscles, while the prey is held with the paws, must tend to pull the condyles of the jaw out of the glenoid cavities, which is prevented by the nature of the mandibular articulation. In the case of the seals the method involves no forward pull upon the jaws, but a principle in natural philosophy is taken advantage of, by which, with no more expenditure of force,

the same end is attained as by the cat. The sudden lurches give the mass of the fish a great momentum, which is suddenly arrested, resulting in its breaking in two, when, with little chewing, the piece held by the teeth is swallowed, the throat seeming to be surprisingly dilatable. By what process a seal was ever capable of fathoming any principle of physics is more than I propose to explain, but such are the facts. It may be added that what holds in respect to habits of tearing the food in the cats, also holds in respect to the bears, weasel family, and raccoons, and in a less degree in the dogs and hyenas.

The condyle in the *Hydrochærus* is exceedingly elongated, the antero-posterior diameter of the condyle proper exceeding twice its transverse diameter, which fits into a groove-like glenoid cavity, looking somewhat as though it had been cut out with a rabbet plane. The sides of the groove are vertical, and at right angles to the bottom; it is also longer than the condyle proper, which is not by any means neatly adapted to fit it as is usually the case. So marked is this artificial appearance that the first time I beheld it I made a careful examination to see if some one had not been carving it into what I thought was a fanciful shape, as a trick to deceive. When the reversed inclination of the teeth above and below is noticed, together with the insertion of the muscles, it is plain that the condyle has a reciprocating motion in this groove (glenoid cavity), which goes a great way in ex-



borodonts, selenodonts, and tapirodonts, may be regarded as representing the extremes of dental metamorphosis due to the persistent action of the forces exerted in mastication by these latter, and which have been operative since the appearance of the herbivora, the time of which I do not propose to indicate even approximately.

	Upper molar series.		Lower molar series.	
	Anterior.	Posterior.	Anterior.	Posterior.
	mm.	mm.	mm.	mm.
BUNODONTS. ¹				
Hippopotamus amphibius . . .	.16	.101	.15	.107
Chæropsis liberiensis . . .	.078	.07	.74	.069
Babirussa alfurus . . .	.059	.04	.052	.039
Sus indicus . . .	.068	.043	.068	.049
Dicotyles torquatus . . .	.049	.043	.049	.038
Phachærus æthiopicus . . .	.069	.055	.065	.047
SELENODONTS.				
Titanotherium prouti . . .	.253	.117		
Helladotherium duvernoyi . . .	.206	.104		
Anthracotherium magnum . . .	.08	.034	.056	.034
Sivatherium giganteum . . .	.219	.139		
Equus caballus . . .	.127	.085	.095	.062
Gazella euchore . . .	.062	.031	.039	.024
Connochætes gnu . . .	.089	.047	.059	.041
Alcelaphus caama . . .	.081	.052		
Capra hircus . . .	.06	.035	.037	.028
Ovis montana ♂ . . .	.072	.045		
Ovis aries . . .	.069	.044	.049	.031
Cariacus columbianus . . .	.068	.045	.049	.033
Cervulus sp. . .	.059	.038	.046	.03
Alce malchis ♂ . . .	.137	.088	.103	.058
Antilocapra americana . . .	.072	.049	.052	.034
Rangifer tarandus . . .	.091	.069		
Cervus canadensis . . .	.115	.075	.085	.058
Camelus dromedarius . . .	.112	.052	.095	.042
Auchenia glaama . . .	.073	.031	.05	.028
Camelopardalis giraffa . . .	.123	.077	.089	.047
Bos taurus . . .	.137	.103	.099	.077
Oreodon major . . .	.081	.047		
Rhinoceros indicus . . .	.158	.09	.124	.081
TAPIRODONT.				
Tapirus americanus . . .	.096	.055	.087	.05

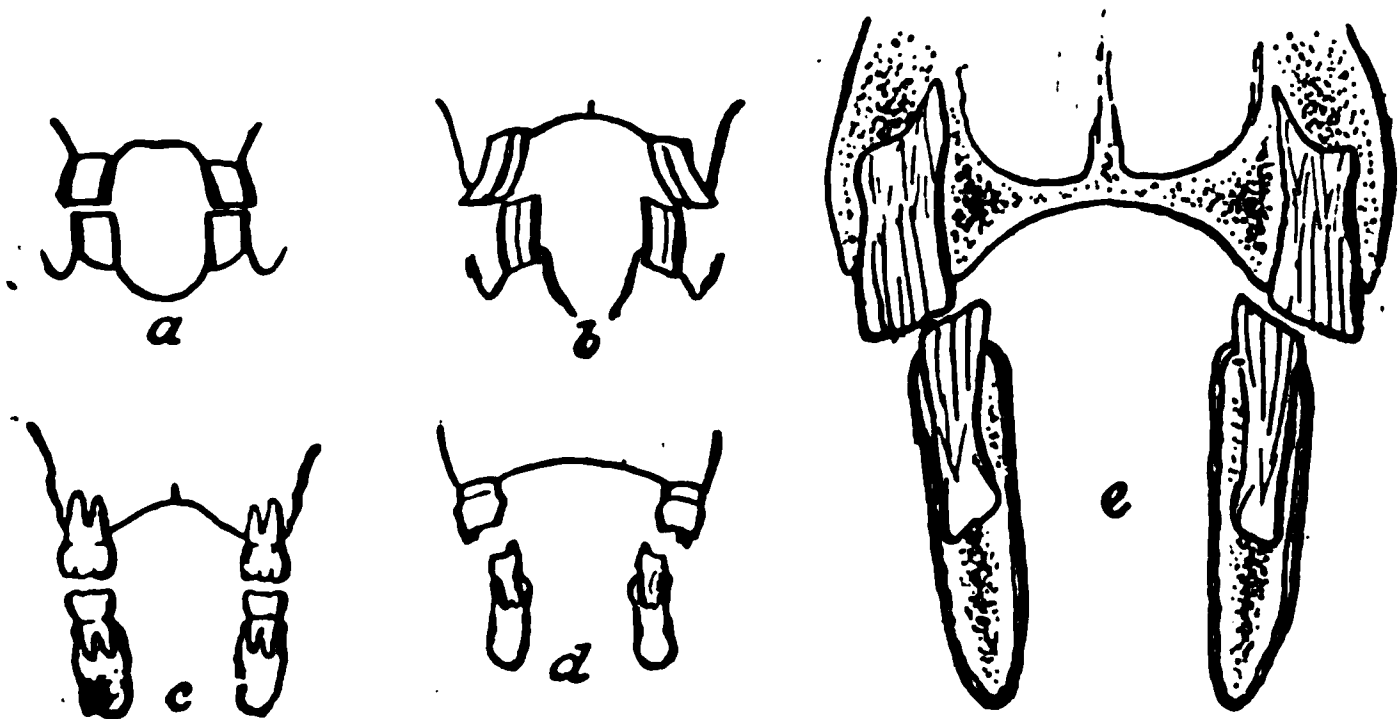
¹ The measurements were made from the external borders of the crowns of the molars of one side to the external borders of the crowns of those of the other side, at the anterior and posterior ends of both the upper and lower series.

	Upper molar series.		Lower molar series.	
	Anterior.	Posterior.	Anterior.	Posterior.
TRICHECODONTA.				
	mm.	mm.	mm.	mm.
<i>Manatee australis</i> . . . . .	.087	.089	.084	.08
<i>Halmaturus dorsalis</i> . . . . .	.088	.022	.090	.02
<i>Petrogale penicillatus</i> . . . . .	.028	.018	.028	.018
<i>Phalangista vulpina</i> . . . . .	.025	.022	.022	.017
<i>Hypsiprymnus caniculus</i> . . . . .	.02	.015	.017	.012
RODENTIA.				
<i>Sciurus</i> , sp. . . . .	.014	.019	.013	.01
<i>Spermophilus</i> , sp. . . . .	.0185	.011	.013	.011
<i>Cynomys ludovicianus</i> . . . . .	.021	.019	.018	.016
<i>Arctomys monax</i> . . . . .	.037	.0225	.024	.022
<i>Tamias</i> , sp. . . . .	.008	.007	.007	.006
<i>Hydrochærus capybara</i> . . . . .	.055	.024	.057	.038
<i>Castor fiber</i> . . . . .	.032	.024	.027	.019
<i>Geomys bursarius</i> . . . . .	.01	.0015	.0105	.009
<i>Mus rattus</i> . . . . .	.008	.0075	.009	.008
<i>Neotoma</i> . . . . .	.01	.009	.01	.009
<i>Sigmodon hispidus</i> . . . . .	.0085	.007	.008	.007
<i>Fiber zibethicus</i> . . . . .	.013	.013	.013	.013
<i>Hystrix cristata</i> . . . . .	.027	.026	.025	.024
<i>Lepus cuniculus</i> . . . . .	.023	.021	.018	.015
<i>Cœlogenys paca</i> . . . . .	.027	.026	.025	.023
<i>Lagostomus trichodactylus</i> . . . . .	.027	.022	.022	.015
<i>Dasyprocta</i> , sp. . . . .	.022	.022	.018	.016

I append a series of similar measurements of primates, to fur-

At Fig. 6, diagrammatic, transverse sections through the jaws of several genera of mammals are shown: *a*, shows the isognathous arrangement in *Fiber zibethicus*; *b*, the anisognathous arrangement in *Lepus cuniculus*. These two show the extremes in rodents; in the first, the teeth of both sides are perfectly parallel; in the latter, neither are they parallel, nor are the series of molars in opposite sides of the upper and lower jaws separated by the same interval. *Fiber*, in some respects, calls to mind the dentition of bunodonts, while *Lepus* reminds one of the selenodont system. The differences are here to be regarded as arising, in a large measure, from the strains incident to mastication, as the contact of the upper and lower molar teeth of *Lepus* always takes place first upon the outer portion of the crown of lower ones, and the inner portion of the crown of the upper ones; and after contact the movement of the jaw is from within outwards, causing the upper molars to be pressed outwards, and the lower molars inwards, eventually causing the upper series to recede from each other, and the lower series to approach each other, probably carrying the rami along in the changes. Nor does the change stop here. The molars are apparently curved outwards above and inwards below from the same cause.

Fig. 6.



Cross-sections through the maxillary apparatus of:— *a*. *Fiber*. *b*. *Lepus*. *c*. *Dicotyles*. *d*. *Cervus*. *e*. *Equus*.

The movement in *Fiber* is totally different, though at times there are indications of lateral movement. It seems to be from before backwards, or a reciprocating movement.

In Fig. 6, c, we have a diagram of a transverse section of the jaws of *Dicotyles*, where, as in *Fiber*, the series are nearly parallel in both jaws, and nearly exactly isognathous; the jaws open and close without a particle of lateral motion. The food, in such a case, is pounded as in a mortar, with a chopping motion of the jaws. The anisognathous arrangement is represented in Fig. 6, d, of *Cervus*, and e that of the horse; both have extensive lateral motion, with corresponding anisognathism; the teeth are also, to some extent, inclined outwards above, and inwards below, as observed in regard to the dentition of *Lepus*. The method of trituration is also very different from *Dicotyles*. It is here ground as in a mill, the reversed enamel patterns of the opposing molar series simulating most closely some of the mechanical devices used by man as grinding mills. The lower jaw, with its molars, however, represents the millstone, and the upper the "bed-stone" or surface upon which it acts with the glenoid cavity as the point from which its oscillations are propagated.

From the preceding tables of measurements the work of constructing a series showing the relation of mandibular movement to anisognathism would be an easy task; the movements would in every case have to be observed, and in all cases where I have been enabled to do so I have found this relation to subsist. We are met, however, by a most anomalous type of anisognathism amongst the cavys, especially in *Cælogenys paca*, where the in-

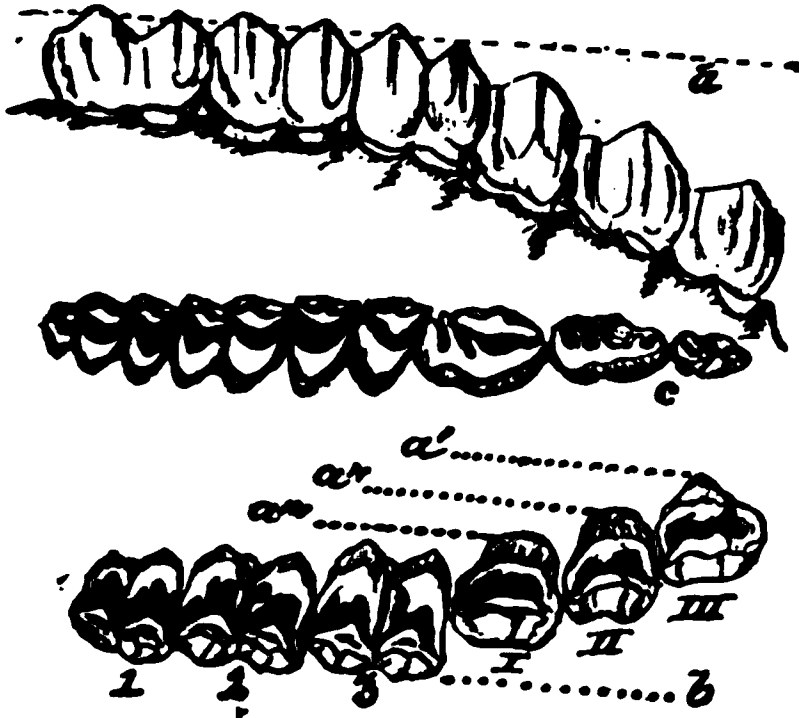


There is evidence in the enamel foldings to show that the same kind of strains were operative here as elsewhere.

A matter which has considerable interest in this connection, is what I have ventured to call *displacement due to strains*. The evidence is met with all through the anisognathous artiodactyla and periosodactyla. The relative position of the molars and pre-

molars in *Cervus* is shown in Fig. 7, *a*; the molars, 1, 2, 3, are directly behind each other; they seem to have been shoved from the line *a'* through *a''* and *a'''* until their outer borders have reached the line *b*; the premolars, I., II., III., have meanwhile been left with their inner faces touching respectively the lines *a'*, *a''*, *a'''*. The outer faces of the premolars are parallel to the line *b*, as though the displacing force had acted

Fig. 7.

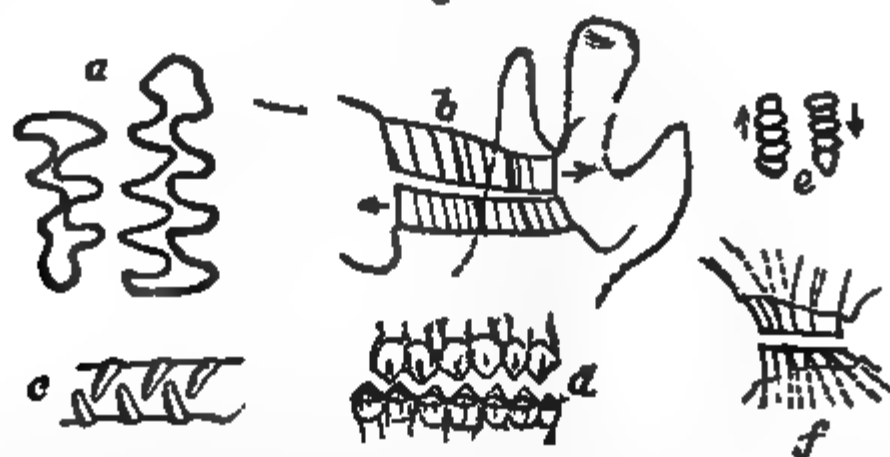


Upper figure, external view of upper molars of *Cervus*. Middle figure, lower molar series of right side of same, not displaced, and lower figure, left upper molars of same, greatly displaced.

equally upon the anterior and posterior portions upon the inner side. This displacement is uniformly the greatest in the later forms, most anisognathous, and with greatest lateral excursion of the mandible. In the molars of the mandible, *c*, no such displacement occurs as noticed in the upper molars; the reason seems to be that the lower teeth, confined as they are to the narrow ramus, cannot undergo such displacement. The force of the mandible always acting to push the upper teeth outwards, since they always first come into contact upon the inner border of the crowns of the upper molars and the outer of the lower ones, would also react powerfully, during mastication, upon the lower molars, tending to push them inwards, and approximate the series (rami) of opposite sides. The molar series of the mandible of the giraffe are, as a whole, slightly convex internally; the reverse of the upper series, which is convex externally. The reversal of this convexity is in keeping with every other character. The displacement seems to be greatest where the masticatory muscles

can act with the greatest force—that is, nearest the articulation of the mandible with the skull. Amongst rodents having a reciprocating motion of the mandible this displacement of one part of the series, while others remain undisturbed, is not very great where only the backward and forward reciprocating movement is present, but sometimes lateral movements are also executed which causes displacement in two directions in both upper and lower molar series. Usually the changes could not be called displacement, but rather a bending or deflection of the teeth in two directions, either backward and outward, or forward and inward. The first condition is usually found in the upper molars, and the second in the mandibular molars of rodents.

Fig. 8.



a. A last upper and a first lower molar *Arvicola*. b. Diagram of molars of *Fiber*, show-

is entirely lateral. At *c* the alternating, interlocking, haplodont teeth of *Delphinus* are shown almost entirely prehensile, not having attained the specialization of molars. The recent proboscideans, with their numerous transverse enamel plates, are simply the more compressed, transverse crests of *Trilophodon* and *Tetralophodon* in greater numbers. The crests, in a young state of the teeth, are present, but are afterwards worn off to a common level from the movement of the mandible from behind forwards.

The curious analogy of the method in which the succession and wear of the molars and cross-crests takes place in ungulates and proboscideans is worth noticing; in the former, the first and most anterior true molar is most worn; in the latter, the anterior cross-crests in both mastodons and elephants are the first to be worn, the heel or posterior part of the tooth remaining frequently totally unused. The succession of molars, vertical and horizontal, secures the same results in both. The first true molar of ruminants is the first to be protruded; its anterior pair of cusps, as well as those of its fellows behind, are most worn and longest, so that a mere increase in the number of transverse pairs of cusps heterochronously protruded, would give us practically the same result as the horizontally succeeding molars of proboscideans.

I cannot dismiss this subject without a reference to the skull of an Australian in the Morton collection of the Academy of Natural Sciences of Philadelphia, No. 1327, with 35 teeth, 34 of which are normally arranged, there being a supernumerary molar on each side above. If these had been repeated in the mandible, the dentition would have been as low as that of the South American monkeys. As it is, it is lower than the gorilla and chimpanzee in this respect, and shows the tendency of even primates to revert towards the primitive formula of 44 teeth prevalent in eocene times.¹ The jaws are massive, with a most pronounced pithecoïd squareness in front, its prognathism being in marked contrast with the beautiful orthognathous skull of the European. The point, however, which has a practical bearing, is the fine state of the teeth and their massiveness as compared with the teeth of the

¹ In a skull of *Ateles geoffroyi* from South America, I have observed that there were ten teeth in the upper left-hand maxillaries, a number which, if it had been repeated all round, would have given forty teeth as the formula, which is within four of the archetypal forty-four. Lemurs have the thirty-six, in common with the lower South American monkeys.

higher races. The incisors are fully twice the mass of those of the present man, and the molars show an almost equally great development. In explanation of this we have not far to look. We are informed by various authorities¹ that these people were totally ignorant of boiling, but that everything was roasted, or even eaten raw, which involved more work for the teeth than falls to their lot now-a-days, and which must powerfully react upon their development. If, as we believe, and as the facts warrant us in believing, that the dental armature becomes more massive as strains become more frequent and severe through the passage and survival of herbivorous types from eocene to modern times, it is almost equally certain that, in the event of the introduction of cookery, with its constantly increasing refinements, there must be a diminished amount of strain upon the teeth, tending to cause atrophy or degeneration.

Cusp-Shaping Forces.—We now come to the consideration of the way in which the cusps of the teeth have been modified by the various mandibular movements, culminating in the crescentoid form and its modifications. We have assumed, as we have had evidence for doing, that many of the parts associated in the function of mastication were greatly modified and brought to their present shape by mechanical resistances incident to the performances of such function, our next purpose will be to show that a similar process has been silently and powerfully at work in the



to its surroundings since geology and palæontology afford such abundant evidence of the constant struggles on the part of life to cope with the altered conditions. To all acquainted with the leading facts of geographical distribution of animals and plants it is well known that some of the most intimate relations exist between flora and fauna, fauna and fauna, flora and fauna and climate, how that elevation due to geologic changes affects climate, and how that telluric changes (orbital), preponderating over all else, should modify all the others, as Prof. Croll¹ would have us believe.

I believe that the changes in these great elements of surrounding conditions may have been adequate to produce either the annihilation or the divergence and survival of organic types. Those creatures which were not in harmony no doubt were often destroyed in affecting the readjustment, because in some the adjustments could not be brought about quickly enough to prevent the fatal waste of efforts in overcoming greatly unbalanced relations. Those that overcame this readjustment survived with modifications. Then, again, there may have been no sudden modifications, but slow changes to which organisms could readily adapt themselves; and, again, there is no telling how much intelligence may have had to do in the struggle, yet there is very little that can be predicated in respect to this by brain-bulk, because if such instances as the beaver, the bee, and the ant are cited, it is at once seen that, even supposing the bulk of brains to augment as recent times are approached, it is not altogether safe to lay too much stress upon brain-mass as an index of intelligence.

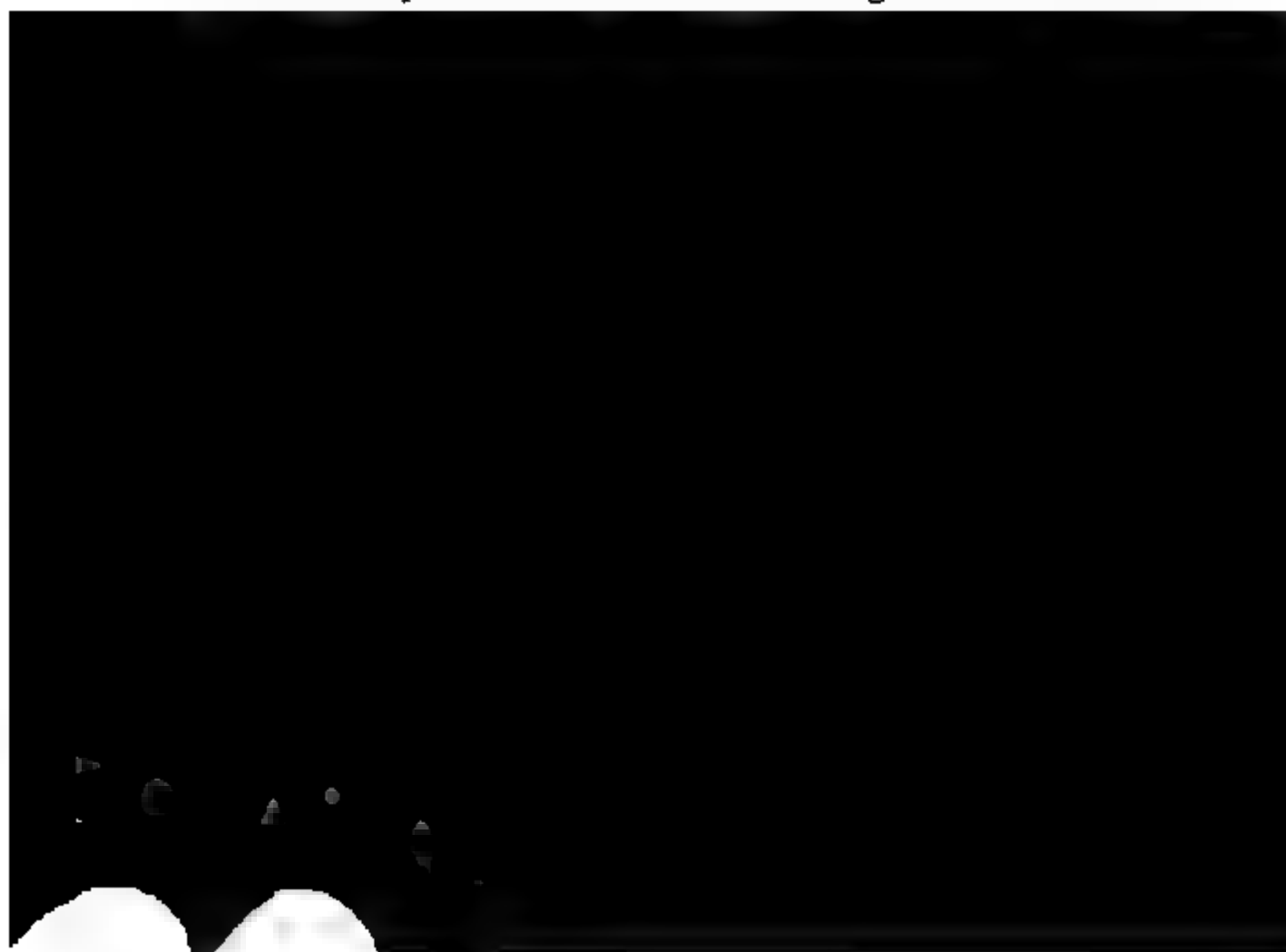
The divergence of the educabilian orders of mammalian vertebrates from a forty-four toothed bunodont type with five toes is held by the most eminent authorities. The prevalence of these two characters in eocene mammalia with their gradual disappearance through later forms is one of the strongest arguments in favor of the theory of descent. The gradual increase in the length of the diastemata between molars and incisors from none at all in many eocene forms to the immense interval between the two in such forms as the horse and giraffe is the first point. Another is the prevalent departure from primeval pentadactylism towards monodactylism, or its equivalent, by the fusion of one or more

¹ Climate and Time, Jas. Croll. London, 1875.

parts into a single one, as, for example, the horse and artiodactyl ruminants. The tendency to monodactylism, it is believed, is due to the strains incident to locomotion affecting the growth and nutrition of these parts. It would, therefore, seem that, considering the weight of opinion upon the origin of diastemata and monodactylism, that the teeth should likewise, as characters of secondary morpbic and systematic value, and so admirably conditioned for great modification, manifest very sensibly the influence of such conditioning forces.

If environments affect choice of food, etc., it must follow, as a necessary consequence, that different methods of prehension and comminution must be employed in different animals to correspond with the nature of the food, which would effect corresponding dental differentiations. These, in turn, make further differentiations, which are successively fixed by the law of heredity, less difficult in succeeding generations, until extremes are reached. This is just what we have tried to show in the two extreme types of mandibular movement, vertical and lateral, and that the former passes gradually into the other just as it can be shown that the bunodont type of tooth gradually passes into the selenodont. Two or three stages of cusp modification are sometimes observed in the same tooth, while as many as six or eight or more tooth modifications may be counted in the teeth of the whole series.

Odontomorphic Centres.—While making measurements of the



with the cross-crests and bottoms of the valleys of the molars of both sides when produced across their crowns.

It is proposed for convenience to designate the teeth, the cross-crests of which coincide in curvature with arcs described respectively from the right and left glenoid cavities as centres, for the molars of these sides respectively, as *biaxial*; and those where the centre of this coincident arc is medial on the basi-sphenoid bone, or midway betwixt the condyle, as *uniaxial*. The centres may be named odontomorphic, or tooth-shaping, since they are the fulcra which control the forces which slowly modify the shapes of the teeth and their component tubercles. The biaxial molar is by far the commonest. I have observed it in the following orders: Edentata, Sirenians, Proboscidiens, Rodents, Perissodactyles, Artiodactyles, Hyracoidea, and Marsupials. The following is a list of some of the observed genera of both classes:—

Biaxial.

Ovis.
Alce.
Cervus.
Antilocapra.
Alcelaphus.
Antilope.
Gazella.
Auchenia.
Camelus.
Sivatherium.
Bos.
Titanotherium.
Equus.
Tapirus.
Phalangista.
Phascolomys.
Trilophodon.
Nototherium.
Megatherium.
Hyrax.
Dasypus.

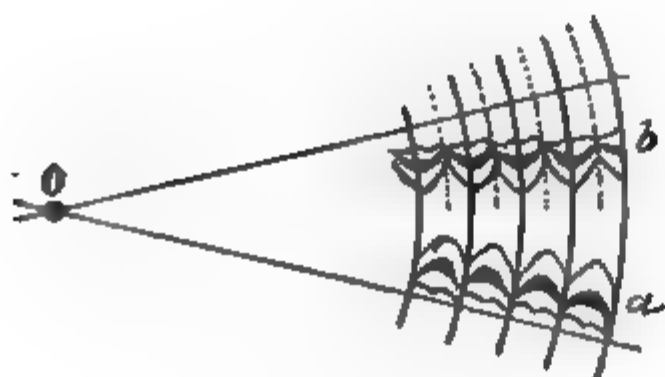
Uniaxial.

Tragulus.
Hyomoschus.
Moschus.
Amphitrachelus.
Leptomeryx.

It will be observed that the *Tragulidæ* monopolize the uniaxial plan, though *Cervus columbianus* is very nearly uniaxial.

In Fig. 9, representing diagrammatically the mechanism of mastication in selenodonts, the curvilinear path of the excursion of the mandibular series of molars, as well as the reversal of the selenoid

Fig. 9.



Ideal diagram, showing the mode in which the lower molar series, *a*, sweeps over the upper series, *b*. The movement being constantly regulated from the mandibular articulation, or odontomorphic centre, *O*.

cusps of the upper and lower series respectively with the ideal odontomorphic centre, *O*, in the mandibular articulation, the gist of the whole matter of tooth modification becomes plain. It is observed that opposite those parts which have the greatest transverse diameter, or which are strongest of the opposing series,

b, impinge upon their fellows, *a*, of the opposite series at the weakest points, or those parts having the least transverse diameter, and vice versa. It looks as though the strains incident to mastication has pressed the sides of the cusps of the teeth flat, and curved their cornu outwards in the upper series, and inwards in the lower, by the oft-repeated excursion in one direction. The action of the parts in life appears to be constant, that is, the molars of the mandibles of the right side always moving outwards when crushing the food, and the same of the side opposita. The movements are often, for many minutes in succession, made in the same direction, then in the other. It is found, upon careful

treme selenodont, *e* and *f*. The cusp, *a*, is the type observed in the early Miocene genus *Entelodon*, or in *Pliolophus* of the Eocene; *b*, an external cusp of an upper molar of *Leptochærus*; *d*, an external cusp of an early ruminant (*Oreodon*); *e*, outer and inner anterior cusps of a young *Cervus*, shortly before protrusion from the alveolus; and *f*, a premolar of *Coryphodon*. A host of additional examples might be given to enforce the idea meant to be conveyed, but which would simply be repeating with another series of species what has already been indicated, and which can be fully confirmed by reference to works of Leidy, Kowalewsky, and Cope on Tertiary mammalia.

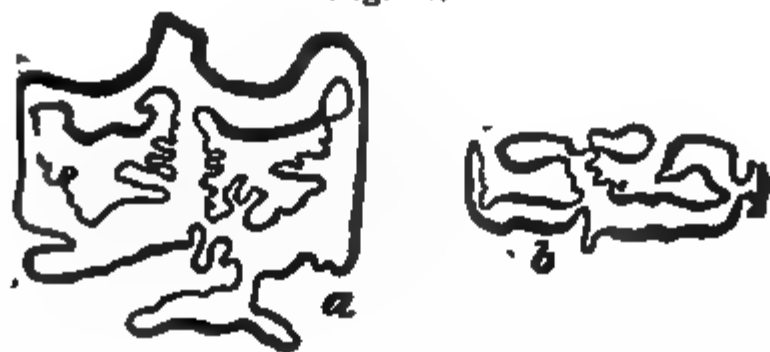
I am aware that *Coryphodon* is an early form, occurring in the Eocene formation, and is perhaps not as well chosen a case to illustrate the modern extreme as might have been selected. This is, however, a superficial objection, since the crowns are very short, with the short roots characteristic of the mammalia of early periods. It seems to be simply a case in which the modifications took place with greater rapidity than in later species. If the whole order of ungulates did not concur in the evidence which they yield, an objection might be raised, but in all of them the reverse direction of the cornu of the cusps of opposing series is the same; in all the mandibular movement is either lateral, or becoming so; almost every family of them shows a progressive intensification of these characters, and it would seem that no further evidence were needed to show that *the necessary actions of an animal modify most profoundly the form of even the very hardest of its tissues*.

It is proposed to close the discussion with the consideration of a few special cases of the various methods of cusp-blending, wear, and flexure. In all the selenodont mammals the flexure of the cornu of the inner cusps and their lengthening in the upper molars and the outer below is greatest, evidently due to the fact that the strains incident to mastication are more powerfully exerted upon these, and less powerfully upon their fellows on the opposite side of the tooth. The deep flexure of the enamel layer, vertically and medially on the inner side of the upper molars and the outer of the lower ones, is another fact to be noted in many instances as due to the same causes. The jutting outwards of the cornu of the external cusps of the upper molars, and inwards of the internal

ones in the lower series, is another fact capable of a similar explanation.

I apprehend that the plicate enamel layers in the dentition of the horse, of *Sivatherium*, and to some extent in the ox and deer, may be accounted for in the same way; for in these the plication is most marked at such points as are manifestly, according to our theory, subject to the severest strains. In Fig. 11, *a*, the enamel

Fig. 11.



pattern of the upper molar of *Equus excelsus*, and *b*, the enamel pattern of an undetermined species of horse (both from Leidy), show this plication of the anterior and posterior transverse enamel walls of the islands in a marked degree. The plication is greatest in a line parallel with the direction of the strains exerted during mastication. Another circumstance is the greater inclination of the inner cusp of the upper molars outwards, and of the outer

per square inch of transverse section,¹ it is easy to surmise what would be the tendency of the exertion of the force of many square inches in section of masticatory muscle upon the jaws and teeth in mastication. It would manifestly not be consumed in the mere comminution of the food, but it must also react upon the structures which were directly subjected to the resulting strains, viz., the teeth. In a mammal as large as the rhinoceros the area occupied by the mandibular teeth is about 5 square inches, while the maxillary teeth occupy about 10 square inches, as I have roughly estimated from a skull nearly adult; the ratio then of the triturating surfaces of the upper and lower series is about as one is to two. These ratios increase apparently as anisognathism increases, and conversely become equal as isognathism prevails; that is, we may select a perisodactyl, such as the rhinoceros, or an artiodactyl, such as *Bos*, to represent one extreme, and the universal pig as the other.

It will be observed that I have made no attempts at constructing phylogenetic tables, a favorite pursuit with some recent naturalists; this is because I am not satisfied in regard to the value of characters as indicating affinities. I appreciate these most thoroughly, but believe that modifications may be greatly accelerated or retarded by alterations in surroundings over which a modifiable organism has no control, so that the differential effects (generic and specific characters of systematists), produced in a given time, may differ greatly in value—their true value being estimated in terms of force—some requiring but half as much time for their production as others. The possible morphological effects of like mechanical conditions are illustrated in turtles and glyptodons, where the rigid exoskeleton has caused the originally segmented axial skeleton to show a strong tendency to revert to the primitive homogeneous condition without losing its osseous character. The exoskeleton has in fact partially assumed the part taken by the chitinous envelope in the organization of the *Articulata*. We may regard the relations here pointed out as the complementary principle demonstrating Spencer's theory of the segmentation of the vertebral axis,² because it must be allowed that opposite conditions must produce opposite effects.

¹ Animal Mechanics, Dr. Saml. Haughton. London, 1873, p. 71; The Principle of Least Action in Nature (Three Lectures), London, 1871, p. 10.

² Principles of Biology, New York, 1867.

Appendix on the Atrophy and Hypertrophy of Incisors.—Without stopping to consider the archetypal or normal forms, the principal groups which manifest the extremes of modification of the incisive elements may be tabulated as follows:—

Rodentia.	}	Hypertrophied incisors with special functions.
Tæniodonta.		
Proboscidea.		Greatly hypertrophied, becoming weapons of offence and defence; function assumed by a proboscis.
Dinocerati.	}	More or less atrophied; function assumed by the lips, or a short proboscis.
Rhinocerotidæ.		
Ruminantia.		Upper incisors absent; function partially assumed by the tongue and muscles of the neck.
Edentata.		No incisors; function partially or entirely assumed by the tongue.

As is now believed,¹ the great specialization of the median incisors of rodents is due to the severe work to which they are persistently applied during the phylogeny of the group, but the extreme of hypertrophy is reached in the *Proboscidea*, where it has been so extensive as to render the teeth useless in the performance of their primary function, which has been exchanged for a new one, viz., a defensive function, while the primary one has been assumed by the greatly developed proboscis used both as a drinking horn and as a hand to grasp and wrench vegetable aliment from its attachment and convey it to the mouth. A fact which points to the conclusion that the tusks of the elephant were

look in the direction of some earlier and more generalized form as a starting point from which it is possible to derive the organ so characteristic of Proboscidiens. In this position I find I am in accord with Prof. Cope, who has stated his views upon this matter more or less distinctly at several places in his extensive writings.¹ My reasons, based wholly on teleological evidence, for not believing the *Dinocerata* to be in the direct ancestral line which culminated in the elephants, is the presence in the former of a variable number of pairs of horns, and in *Dinoceras* the great pair of upper molar teeth are written down as canines by Profs. Leidy, Cope, and Marsh, which, with the absence of upper incisors, gives us no probable beginnings that may be regarded as homologous with the tusks of *Elephas*. However, the tusks of *Proboscidea*, as now known from fossil forms, have been extensively modified in size, situation, and direction of curvature. We may state the modifications as to implantation of the tusks (incisors) in the various forms, thus:—

$$\begin{array}{lcl} \text{Dinotherium, I.} & \frac{0-0}{1-1} & \\ \text{Mastodon Angustideus,} & & \\ \text{M. longirostris,} & \left. \vphantom{\begin{array}{l} \text{M. longirostris,} \\ \text{M. productus, etc.} \end{array}} \right\} \text{I.} & \frac{1-1}{1-1} \\ \text{M. productus, etc.} & & \\ \text{Elephas, sp. I.} & \frac{1-1}{0-0} & \end{array}$$

From the tenor of the foregoing facts, I am led to conclude that, with the disappearance of the primary functions of the incisors in Proboscidiens, and their assumption of a secondary defensive one, the proboscis was gradually developed, while the mouth, as it became more elevated from the level of the ground by the shortening of the neck and the assumption of the long, gravi-gradous pillar-like limbs, were assisting factors in the process. Whatever was the cause of the incisors becoming weapons of defence was the cause of the initiation of a process of development of the external nasal organ, resulting in its present structure and importance. There was probably no organ so directly available as what was then a rudimentary proboscis, seeing that all other parts (limbs), probably by reason of the animal's bulk, must sub-

¹ U. S. Geolog. Surv. Terr., 6th Annual Report, Washington, 1873, p. 647; U. S. Geograph. Surv. W. of the 100th Meridian, vol. iv. 1877, p. 282.

serve purposes of locomotion. Further, after once having reached that stage which made the incisors available as weapons, we can understand how the violent uses to which these parts were and are put only served to carry the hypertrophy still further.

The *Dinocerata* and *Rhinocerotides* present a case where the partial assumption of the incisive function by a very flexible and powerful lip has reacted upon the development of the incisors, causing them to become rudimentary. I infer from the rather elevated and thickened nasal bones of the *Dinocerata* that these creatures had a long protrusible upper lip, if not a short proboscis, and the observed correlation between such osteological conformation and protrusible lip in living forms is still further evidence; so is the fact that, in a form (*Palæosyops*) allied to the genus *Titanotherium*, the nasals are strongly produced as in the Tapir, to which it is also allied. I think it improbable that *Dinocerus* possessed a prehensile tongue, a view contradicted by the relatively immobile upper lip, with two or three exceptions, of the *ruminantia*, that are similarly without upper incisors. The horse with his prehensile upper lip has not been considered, but we find, upon observation, that the power he exerts with it is very feeble, and acts rather as a collecting apparatus for the purpose of bringing herbage within reach of his incisors, the most complex, with one exception, in the whole mammalian sub-kingdom. The proboscis of the Tapir is likewise only a grasping instrument, and

aborted. A bird-like character is assumed in one instance (*Myrmecophaga*), in which the pyloric end of the stomach becomes gizzard-like, small pebbles being found within. The extinct and recent sloths, as well as armadillos, have long prehensile tongues, which, it is believed explains their want of incisors. Brehm says (*Thierleben*) the tongue of the living sloth is used like a hand, and Owen thinks the tongue of *Megatherium* was prehensile. From what I have seen of living armadillos I have reason to believe that the *Hoplophoridæ* were similarly possessed of prehensile tongues. The well-developed hyoids of this group, as Prof. Burmeister¹ has represented them, would also favor this view. It may be objected to our explanation that no fossil *Edentata* have been found *with* incisors, which should be the case if our theory is the correct one; to this we may reply that so far no *Edentata* have been described from South America older than early pliocene, so that we may look with some degree of confidence for the future discovery of forms with the required incisors or their rudiments from the eocene or miocene of that great continent. A group so sharply defined as the *Edentata* will then have shared the fate of some of the others which were considered as isolated, with irreconcilable chasms intervening, until, thanks to the labors of American palæontologists, such have been in a large measure filled up. That the want of incisors in existing edentates is no proof of their absence in the forms from which they were derived, receives some support from the fact that rudimentary teeth have been found in the embryos of toothless whales, and also, as should be expected in embryo, *Trionychidæ*, a low group of the *Testudinata*, if, as has been held, these latter are remotely allied to the toothed crocodilians.

The following summary of the views arrived at in the foregoing pages is offered:—

1. That the earliest and simplest type of mammalian jaw-movement was that in which the mouth was simply opened and closed, without mandibular excursion, and coexistent with the simple haplodont or bunodont molar.

2. That the development of the various kinds of excursive mandibular movement has apparently been progressive.

¹ *Anales del Museo Publico.* Buenos Ayres, 1866-73.

3. That as the excursive movements have increased in complexity there has been an apparent increase in the complexity of the enamel foldings, ridges, and crests.

4. From the fact that the foldings, etc., have apparently been modified in conformity to the ways in which the force used in mastication was exerted, it is concluded that the various modes of crest and tubercular modification are related as effects to the diverse modes of mandibular movement.

5. It is apparent from the facts presented throughout the context that the mandibular articulations, and correlatively the whole skull, have probably been modified in shape by the movements made by the jaws and the forces exerted in executing them.

6. From the fact that incisor teeth are partially or entirely absent or relegated to another function in forms which have long prehensile tongues, mobile, prehensile lips or proboscides, it is held to be probable that such disappearance of the incisive dental elements is due to the assumption of their function by the prehensile organs indicated.

**ON THE ASSOCIATION OF GROSSULARITE, ZOISITE, HEULANDITE, AND
LEIDYITE—A NEW SPECIES.**

BY PROFESSOR GEORGE A. KÖNIG.

On Crum Creek, just above Chester, Delaware County, Pennsylvania, the gneiss formation has been kept opened for many years by the quarries of Messrs. Deshong. The gneiss shows here a granitoid structure, with just enough of mica to produce a very straight fracture, combining thus the toughness of granite with the easier workability of the gneiss. The stratification strikes nearly north and south, while the dip is almost vertical. Seams of coarse-grained granite are frequent in the granitoid gneiss, carrying, occasionally, crystals of Orthoclase, black Tourmaline, and Beryl of unusual size and beauty. In the eastern part of the quarry, the structure of the gneiss is schistose, in fact, the rock is more properly called mica schist, the feldspathic element receding considerably. This rock is interstratified with seams of gray quartz, and in blasting one of these seams recently, near the foot of the cliff, which is here about forty feet high, Mr. A. O. Deshong observed minerals, the like of which the quarry had never produced before. I am much indebted to Mr. Deshong's liberality, who placed this entire material in my hands. Through the falling of top rock the spot is now covered; but it will be reopened in the spring, and more materials of interest may be expected by mineralogists. Some of the specimens have a very pleasing appearance through the contrast of the green, brownish-yellow, and rose color of the associated minerals.

1. *Grossularite. a. Yellow Variety.*—In well-defined crystals, some two centimetres and more in diameter. Form chiefly the rhombic dodecahedron, ∞O in combination with $2O2$. One crystal entirely embedded in quartz is elongated, and easily mistaken for a tetragonal form. Mostly granular massive. Color from brownish to amber-yellow. Lustre vitreous; fatty on the fracture. Transparent. $H=6$. Spec. gr. = 3.637 at $20^{\circ} C$.

Chemical Characters.—The mineral fuses at 3 to a brownish or slightly greenish glass. With soda and borax in O.Fl manganese reaction. Not acted upon by hydrochloric acid, either before or after ignition. The white powder turns straw-color when ignited.

			Quotient.	
SiO ₂	= 89.80	Si = 18.53	0.663	0.663
Al ₂ O ₃	= 21.16	Al = 11.29	0.206	} 0.225
Fe ₂ O ₃	= 3.14	Fe = 2.19	0.019	
FeO	= 0.72	Fe = 0.56	0.010	} 0.642
MnO	= 1.80	Mn = 1.39	0.025	
CaO	= 34.00	Ca = 24.29	0.607	
MgO	= trace			
Ignition	= none			
	<hr/> 100.62			

These quotients furnish the ratio:—

$$\text{Si} : \text{Al} : \text{Ca} = 2.940 : 1.00 : 2.658.$$

Or



b. Greenish Variety.—Not observed in crystals. Massive granular. Color light grass-green to nearly white, the two varieties seem to pass into one another. I observed some striated planes, and thought they might belong to the following species of Zoisite, but fragments placed in the flame did not show intumescence, and fused like the yellow variety. Lustre on fracture less fatty than in the yellow variety. Highly transparent. $H=6$. Spec. gr. 3.238.

Chemical Characters.—Fuses at 3, and with the fluxes gives strong manganese reaction. Not materially attacked by hydrochloric acid either before or after ignition.

Chemical analysis made by my assistant

small quantities involved. Neither of these varieties has been identified in the United States by analysis.

Andradite and Pyrope are the usual varieties known in the American gneiss formation.

2. *Zoisite*.—Massive, cryptocrystalline, and in aggregation of small prismatic crystals. In the latter condition the specimen is friable between the fingers, as the individual crystals are but loosely cemented together. The shape of the crystals resembles very much that of Pyroxene. The striations on the prismatic faces are not noticeable; but an oblique cleavage seems to be present. I could not obtain satisfactory measurement. The prismatic angle was found approximately $= 107^\circ$. The prism was terminated in one crystal by two brachydomes too small for measurement.

Color rose-red to pale pink. Strong vitreous lustre. $H = 6$
Spec. gr. $= 3.642$

Chemical Characters.—Swells up in the O.Fl, and fuses at 4 to 4.5 to a white enamel. With soda and borax in O.Fl manganese reaction. Not acted upon by hydrochloric acid either before or after ignition. When heated in the closed tube the rose-color disappears, and the mineral seems gray, yielding a small quantity of water. Upon cooling, the rose-color reappears with its former intensity.

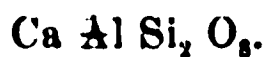
The mean of two closely-agreing analyses gave me:—

			Quotient.	
SiO ₂	= 40.70	Si	= 19.00	0.679 0.679
Al ₂ O ₃	= 33.30	Al	= 17.78	0.326 } 0.341
Fe ₂ O ₃	= 2.40	Fe	= 1.68	0.015 }
FeO	= 0.70	Fe	= 0.57	0.100 }
MnO	= 0.43	Mn	= 0.307	0.005 } 0.366
CaO	= 19.70	Ca	= 14.06	0.351 }
MgO	= 0.15			
Ignition	= 2.40	H ₂ O	= 2.40	0.12
<hr/>				
99.78				

Producing the ratio:—

$$R : Al : Si = 1.07 : 1.00 : 1.991.$$

Or,



And taking the water into consideration we obtain:—



Is the water essential in the composition of Zoisite? Ram-melsberg does not consider it so; and yet all analyses of this mineral show its presence. To me it seems to be essential, as I connect it with the remarkably distinct intumescence of Zoisite. Intumescence surely is caused by the escape of gas or vapor while the substance is in a semi-fluid state; it is but another form of exfoliation.

Minerals, with eminent basal cleavage and water of hydration or of crystallization, exfoliate, as the vermiculites, and to a lesser degree Heulandite; minerals possessing less cleavage, or none at all, exhibit intumescence. This phenomenon, as yet unexplained, is quite worthy of a thorough investigation.

It is possible, that in this, as also in other instances, a hydrated product of alteration is interlaminated with the really anhydrous mineral, thus producing apparent intumescence of the whole. This is merely a suggestion.

3. *Heulandite*.—This Zeolite occurs in cavities or upon either the Garnet or the Zoisite, in the usual form and combinations. A sufficient quantity for analysis could not be collected, but the pyrognostic characters were found to be those of heulandite. It has an olive-green color, probably from an admixture of the following mineral. It is evidently a product of alteration.

4. *Leucite*.—On the quartz, but particularly on the Garnet and Zoisite, I found a mineral substance having the following charac-

		Quotient.	
SiO ₂ = 51.40	Si = 23.94	0.855	
Al ₂ O ₃ = 16.83	Al = 9.51	0.173	0.173
FeO = 8.50	Fe = 6.61	0.118	} 0.248
CaO = 3.15	Ca = 2.19	0.054	
MgO = 3.07	Mg = 1.84	0.076	
H ₂ O = 17.08			
<hr/> 100.03			

This gives the ratio for

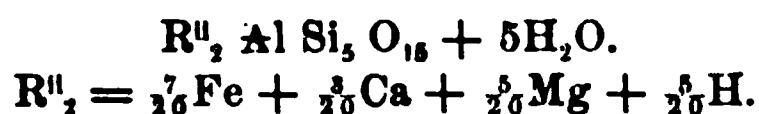
$$\begin{aligned} R^u : R^v : Si &= 1.43 : 1.00 : 4.942. \\ &= 1.5 : 2 : 5. \end{aligned}$$

This corresponds to the oxygen ratio

$$4\frac{1}{2} : 10.$$

But it is much more probable that one atom of hydrogen enters into the molecular equivalent to $\frac{1}{2}$ atom R^u , producing thus a saturated bisilicate.

The mineral has then the general formula



I place this mineral in the system with the bisilicate Zeolites for these reasons:—

1. Similar behavior before the blowpipe.
2. Association and like origin.
3. Similarity of chemical composition, particularly with Heulandite. Both minerals are formed by metamorphosis of Grossularite and Zoisite.

Named after the distinguished comparative anatomist, Dr. Joseph Leidy, of Philadelphia.

ADDITIONS TO MR. COOKE'S PAPER ON "THE VALSEI OF THE UNITED STATES."

BY WM. C. STEVENSON, JR.

In Mr. M. C. Cooke's paper¹ there are forty specimens grouped under "sporidia uncertain." The following are measurements of Schweinitzian specimens, occurring under these names, in the herbarium of the Academy of Natural Sciences.

As only the Schweinitzian specimens were examined, other references are omitted in this list.

The marginal numbers correspond to those in the original paper.

95. *Valsa Bignoniæ*, Schw. Am. Bor. 1310.

Sporidia olive-brown, uniseptate, $.0159 \times .0078$ mm.

96. *Valsa scoparia*, Schw. Am. Bor. 1318.

Barren.

97. *Valsa pugillus*, Schw. Am. Bor. 1322.

Evidently a *Sphæronema*.

98. *Valsa sentellata*, Schw. Am. Bor. 1344.

Barren.

99. *Valsa frustrum-coni*, Schw. Am. Bor. 1329.

Barren.

100. *Valsa ciliata*, Schw. Am. Bor. 1349.

- 106 *Valsa allostoma*, Schw. Am. Bor. 1332.

Sporidia allantoid, hyaline, $.009 \times .0031$ mm.

107. *Valsa oligostoma*, Schw. Am. Bor. 1333.

Barren.

108. *Valsa amorphostoma*, Schw. Am. Bor. 1334.

Barren.

109. *Valsa radicum*, Schw. Am. Bor. 1335.

Barren.

110. *Valsa conspurcata*, Schw. Am. Bor. 1336.

Sporidia allantoid, hyaline, $.0062 \times .002 - .0012$ mm.

111. *Valsa modesta*, Schw. Am. Bor. 1337.

Sporidia allantoid, hyaline, $.0078 \times .0032$ mm.

112. *Valsa comptoniæ*, Schw. Am. Bor. 1353.

Immature; asci long, linear.

113. *Valsa variolaria*, Schw. Am. Bor. 1371.

Sporidia allantoid, hyaline, $.0078 \times .0032$ mm.

114. *Valsa conseptata*, Schw. Am. Bor. 1373.

Sporidia allantoid, hyaline, $.0083 \times .0032$ mm.

115. *Valsa papyrifera*, Schw. Am. Bor. 1375.

Large number of asci filled with granular matter, apparently immature. No definite sporidia present.

116. *Valsa ceanothi*, Schw. Am. Bor. 1376.

Sporidia allantoid, nucleated, $.0217 \times .0062$ mm.

117. *Valsa indistincta*, Schw. Am. Bor. 1377.

Sporidia reniform, hyaline, $.0062 \times .0045$ mm.

118. *Valsa quadrifida*, Schw. Am. Bor. 1378.

Sporidia allantoid, hyaline, $.0093 \times .0032$ mm.

119. *Valsa scabriseta*, Schw. Am. Bor. 1394.

Sporidia subelliptical, hyaline, $.0062 \times .0203$ mm.

120. *Valsa expers*, Schw. Am. Bor. 1396.

Sporidia allantoid, nucleated, $.0189 \times .0062$ mm.

121. *Valsa rimicola*, Schw. Am. Bor. 1397.

Not in sufficient quantity for complete examination.

122. *Valsa rhizina*, Schw. Am. Bor. 1398.

Sporidia allantoid, hyaline, $.0093 \times .0032$ mm.

123. *Valsa halseyana*, Schw. Am. Bor. 1319.

Barren.

124. *Valsa lizivia*, Schw. Am. Bor. 1327.

Sporidia brown, uniseptate, strongly constricted at septum, $.0253 \times .0127$ mm.

125. *Valsa tortuosa*, Schw. Am. Bor. 1350.

Unsatisfactory.

126. *Valsa deformis*, Schw. Am. Bor. 1355.

Sporidia allantoid, hyaline, $.0062 - .0083 \times .0015$ mm.

127. *Valsa elopima*, Schw. Am. Bor. 1360.

Examination unsatisfactory.

128. *Valsa leucopia*, Schw. Am. Bor. 1365.

Sporidia subelliptical, hyaline, $.0223 \times .0062$ mm.

129. *Valsa sphinetrina*, Schw. Am. Bor. 1370.

Barren.

130. *Valsa aperta*, Schw. Am. Bor. 1381.

Sporidia allantoid, hyaline, $.0189 \times .0062$ mm.

131. *Valsa vasculosa*, Schw. Am. Bor. 1382.

Sporidia cuneate, nucleated, $.0189 \times .0127$ mm.

132. *Valsa pusilla*, Schw. Am. Bor. 1391.

Barren.

**NOTES ON THE NORTH AMERICAN CARIDEA IN THE MUSEUM OF THE
PEABODY ACADEMY OF SCIENCE AT SALEM, MASS.**

BY J. S. KINGSLEY.

The following paper is merely preliminary to a proposed monograph of the North American shrimps. I would here return thanks to Prof. S. I. Smith, of Yale College, for many favors received.

CRANGONIDÆ.

CRANGON Fabricius.

***Crangon vulgaris* Fabr.**

I find this species in collections made by Dr. Packard at Fort Macon, N. C. I should be inclined to call the *Steiracrangon Allmanni* of Kinahan (Proc. Roy. Irish Acad. 1862, vii. p. 71, pl. iv.) as this species, there being no constant character to separate them; but Rev. A. M. Norman, in the Report of the British Association for the Advancement of Science for 1868, p. 265, pronounces them unquestionably distinct. The only characters given by Kinahan for the separation are the sulcation of the sixth and seventh abdominal segments, a feature which I have found in undoubted specimens of *C. vulgaris* from our own coast. Nor can the bathymetrical distribution, mentioned by Norman, affect the case, as *C. vulgaris* is common in seventy fathoms. I am also inclined to consider *C. nigricauda* Stm., *C. nigromaculata* Lockington, and *C. alaskensis* Lockington, as *C. vulgaris*, but will not decide until the examination of larger series of specimens from the west coast. Dekay (N. Y. Fauna, Crustacea, p. 25) has this astounding statement concerning this species (under the name *C. 7-carinata* Say), "eyes sessile, and resting on the concave surface of the peduncle of the inner antennæ."

HIPPOLYSMATA Stimpson.

! *Hippolyasmata cubensis*.

Hippolyte cubensis, Von Martens, Wiegmann's Archiv für Naturgeschichte, 1872, p. 136, pl. v. f. 14.

I refer this with a doubt to this genus, though Dr. V. Martens gives nothing in regard to the mandibles and external maxillipeds. The genus *Hippolyte* is northern in its range.

Hippolysmata intermedia, n. s.

Carapax with antennal and branchiostegal spines, rostrum horizontal, extending to base of the third joint of antennular peduncle, shorter than in *H. wurdemanni* Stm., and longer than in *H. cubensis*; the carina extending back to the posterior portion of the carapax; six or seven toothed above, three or four teeth being on the carapax, and three on the rostrum; below with three teeth, the first being directly under the last on the upper margin. Antennular spine extending slightly beyond the basal joint of peduncle; third joint two-thirds as long as preceding, flagella nearly as long as the body, the outer thickened for a fourth of its length, and exhibiting traces of a division. A spine on the outside of the basal joint of antennæ, antennal scale narrow, regularly tapering, extending over half its length beyond the rostrum; flagellum longer than the body.

External maxillipeds elongate, pediform, extending beyond the antennal scale, the carpal joint reaching the tip of antennal peduncle. Feet of first pair reaching the extremity of the antennal scale, fingers half as long as palm; hand, carpus, and meros subequal. Feet of second pair elongate, filiform, carpus multiarticulate. Telson narrow, tapering, the apex acute.

Length.	Carapax.	Rostrum.	2d pair.
25 mm.	6 mm.	3 mm.	19 mm.



ing the tip of antennal scale. Basal joint of antennæ with a small spine beneath; antennal scale narrow, lanceolate, nearly as long as carapax, peduncle short, flagellum a third as long as the body without rostrum. External maxillipeds short, last joint twice as long as the preceding one. Feet all short, first pair very short, stout, carpus with a spine above, hand inflated, fingers curved, closing completely. Feet of second pair slender, reaching to the tip of antennal peduncle, meros joint as long as the first two joints of the carpus, first joint of carpus as long as the other two, third a half longer than the second; hand hirsute, as long as the last articulation of the carpus. Remaining feet simple; dactyli curved, propodi spinulose beneath. Dorsum of abdomen smooth; sixth segment as long as the two preceding; telson elongate, slender, acute.

Length.
51 mm.

Carapax.
10 mm.

Rostrum.
15.5 mm.

Fort Macon, N. C., A. S. Packard, Jr.

This species differs from *T. lanceolatum* Stm., from China, the only other species that I know of, in the shortness of the rostrum and antennæ, the want of spines on the dorsal surface of the abdomen, etc.

ATYIDÆ.

ATYA Leach.

Atya punctata, n. s.

Compressed, carapax and abdomen everywhere thickly punctate, rostrum short, depressed, carinate above and below, tip acute, lateral angles obtuse, the sulci separating the median from the lateral carinæ deep. Antennular spine falling short of base of second joint, acute; peduncle granulate above, third joint two-thirds as long as second; outer flagellum shorter than the inner, inner three-fourths as long as carapax. A spine on the basal joint of antennæ beneath; antennal scale longer than antennular peduncle, extremity ovate, external margin nearly straight, with a short acute spine. External maxillipeds slender, extending beyond the antennal peduncle. Feet of the first two pairs subequal; meral joints compressed, longitudinally sulcated. Feet of the third pair cylindrical, stout, covered with tubercles interspersed with hairs. These tubercles on the upper surfaces show a tendency to arrange themselves in longitudinal rows, and on the carpus become some-

what spiniform. Ischium three times as long as meros, meros and carpus of the same length, the former being somewhat the stouter; dactylus short, stout, smooth above, a single row of spines beneath, apex acute. Fourth pair of feet resembling the third in ornamentation and proportions of joints, but shorter and more slender. Fifth pair still shorter and more slender, carpus twice as long as meros and slightly longer than the ischium; otherwise not differing from the two preceding. Telson, with the sides straight, extremity truncate; a slight sulcus above, which, in the posterior portion, is divided by a median carina; on each side a row of aculei.

Length.	Carapax.	Third pair feet.
59 mm.	18.5 mm.	28 mm.

Hayti, Dr. D. F. Weinland.

This species differs from *A. scabra* in the longer feet of the first pair, the three last pair more slender, the more tuberculate character of the ornamentation, and in the proportionate length of the joints. The second abdominal segment is also more dilated. From the short description of *Atya occidentalis* Newport, in the thorax and abdomen being punctate; from the *A. tenella* Smith, in the larger feet of the third pair; and from *A. rivalis* in the more obtuse lateral teeth of the rostrum.

Atya occidentalis Newport, *Annals and Magazine of Natural History*, 1847, vol. xix, p. 122. Von Martens, *Archiv für Naturgeschichte*, 1871, p. 135.

Whether this be the *A. occidentalis* of Newport, cannot be determined from his short description, but it presents no conflicting characters.

ATYOIDA Randall.

Atyeida glabra, n. s.

Compressed, rostrum slender, short, extending slightly beyond the base of the second joint of antennular peduncle, horizontal, rounded above, not angulated on the sides, no lateral carinæ; below with two to four teeth near the tip. Peduncle of antennæ unarmed, last two joints nearly equal; outer flagellum about half as long as the carapax; inner more slender, three times as long as the outer. Antennal scale longer than the antennular peduncle, extremity ovate, outer margin straight and armed with a small, stout, acute spine; flagellum nearly as long as the body. External maxillipeds slender, pediform, extending a little beyond the peduncles of the antennulæ. First two pairs of feet smooth and naked; the first as long as the maxillipeds, the second extending to the tip of the antennal scale. Meral and carpal joints of remaining pairs armed below with spines; dactyli short, stout, also with spines. Two posterior pairs subequal. Abdomen smooth, compressed, the sides being higher than is usual in this and allied genera. Telson narrow, sides straight, extremity arcuate-truncate, with numerous small spines; dorsal surface without a furrow, but furnished with rows of small aculei.

Length.	Length of Carapax.	Height of Carapax.	Height of abdomen.
22 mm.	6.5 mm.	3.2 mm.	5.3 mm.

Polvon and Corcuera, west coast of Nicaragua, J. A. McNiel.

PALÆMONIDÆ.

ALPHEUS Fabr.

Alpheus normanni.

Alpheus affinis Kingsley, Bulletin U. S. Geological and Geographical Survey of the Territories, 1878, vol. iv. p. 195.

The specific name *affinis* being already preoccupied in this genus (Guise, Annals of Natural History, 1854, 2d series, vol. xiv. p. 275), it is necessary to apply a new one to the Panama form, and I therefore dedicate it to the Rev. A. M. Norman, of England, who called my attention to the oversight.

PANDALUS Leach.***Pandalus franciscorum*, n. s.**

Carapax with a minute pubescence; antennal and branchio-tegal spines acute; rostrum a fifth longer than the carapax, extending a fourth its length beyond the antennal scales, considerably recurved, ten or eleven teeth above, of which five are on the carapax, and the remainder on the basal portion of the rostrum; distal half of the rostrum above smooth, the apex being minutely bifid or trifid; below with seven to nine teeth, the posterior being the largest. Third joint of antennular peduncle a third longer than the preceding; flagella about as long as the carapax. Basal joint of antennæ with a spine on the outside, and another below; antennal scales long and proportionately narrower than in *P. borealis* Kroyer; flagellum longer than the body. External maxillipeds falling short of the extremity of the antennal scale. Second pair of feet unequal, the shorter extending further forward than the external maxillipeds. Posterior pairs stout, armed with spines below. Fifth and sixth abdominal segments with a spine at the infero-posterior angle. Telson narrow, a shallow furrow on its upper surface, apex obtusely triangular.

Length.
110 mm.

Carapax.
52 mm.

San Francisco, Cal., W. G. W. Harford.

Thor floridanus, n. s.

Carapax with a small antennal spine; rostrum shorter than the eyes, five toothed above, the first being over the orbits, beneath smooth and rounded. Antennulæ with basal joint large, basal spine long, acute, reaching nearly to third joint; second and third joints very short, the second with a slender, acute spine on the outside. Inner flagellum slender, slightly longer than the basal joints; outer about as long as the basal joints, stout, ciliated on the apex and inner margin. Antennæ with a spine on the basal joint, antennal scale reaching as far as the outer branch of antennular flagellum, its inner margin slightly concave, flagellum half as long as the body. Mandibles robust, apical process with five terminal teeth. External maxillipeds slender, pediform, reaching the tip of antennal scale, the penult joint the shortest, antepenult three, and last joint four times as long as the penultimate, the last joint terminated with slender spines. First pair of feet short, stout, meral and carpal joints subequal, the latter with minute spines on the inner margin; hands subcylindrical, the dactyli occupying two-fifths their length. Second pair of feet elongate, filiform, carpus five annulate, third and fourth joints the shortest, equal, fifth, second, and first increasing in length in the order given, the first being as long as the third and fourth together; hand as long as the third and fourth articulations of the carpus, with the fingers occupying two-fifths of its length; meral joint as long as the first four articulations of the carpus. Dactyli and distal portions of the propodi of posterior pairs of feet spinulose beneath. Telson elongate, triangular, apex truncate, spined.

Length.

13 mm.

Carapax.

3.9 mm.

Key West, Florida, A. S. Packard, Jr.

PONTONIA Latreille.

Pontonia domestica Gibbes, Proceedings of the American Association for the Advancement of Science, 1851, iii. p. 196.

In addition to the brief description of Gibbes, I would add the following characters, derived from specimens in the collection of the Boston Society of Natural History from the Bahamas (Dr. H. Bryant).

Antennal spine short, acute; rostrum extending nearly to last joint of peduncle of antennulæ. Third joint of antennular

peduncle but slightly longer than the second; flagella very short, the outer branch the longer and stouter, basal spine short, obtuse. Antennal scale broad, extending as far as antennular peduncle; extremity arcuate-truncate. Feet of the first pair slender, carpus a half longer than the hand. Palm of the second pair a half longer than the fingers; thumb with two teeth, finger with only one, points of fingers crossing. Telson twice as long as broad, margins slightly arcuate as in *P. margarita*, Smith.

Length.	Carapax.
26 mm.	10.4 mm.

. **ANCHISTIA** Dana.

Anchistia americana, n. s.

Rostrum rather broad, nearly reaching the extremity of the antennal scale, upper margin straight, seven to nine toothed, above the first tooth more remote from the second than the second from the third, two to three teeth below. Branchiostegal and hepatic spines present. Basal joint of antennulæ broad, as long as the two following which are equal. Upper and outer flagellum shorter and stouter than its fellow, and bifid for about a fourth of its length; inner and longer flagellum about as long as the peduncle. Basal joint of antennæ with a spine on the outside, antennal scale lanceolate, extremity rounded; flagellum as long as the body. Feet of the first pair slender, elongate, the middle of carpus

PALÆMONETES Heller.**Palæmonetes paludosa.**

Hippolyte paludosa Gibbes. Pro. Amer. Assoc., 1851, p. 197.

Palæmonetes exilipes Stimpson, Annals N. Y. Lyceum Nat. Hist. 1871, x. p. 130. Smith, Rep. U. S. Fish Commission, 1872-3, p. 641, pl. 1., f. 1. Forbes, Bulletin Illinois Museum Nat. Hist. 1876, No. 1, p. 5 and 20.

I believe the species described by Stimpson to be the one mentioned previously by Gibbes, especially since the description of this author agrees, as far as it goes, with specimens of *P. exilipes* from various localities, that it comes from the fresh waters of South Carolina, from whence Stimpson's types were procured. Professor Gibbes says, "The specimens were not quite perfect, having lost some of their feet and antennæ," which would explain their reference to the wrong genus.

PENEIDÆ.**SICYONIA** H. Milne Edwards.**Sicyonia dorsalis**, n. s.

Body small, slightly compressed, carapax minutely punctate. Dorsal crest of the carapax with a tooth at about the middle, and a second near the anterior border. Hepatic spine slender, antennal shorter and stouter. Rostrum horizontal, short, extending slightly beyond the eyes and nearly to the second joint of antennular peduncle, three-toothed above, extremity acute, below entire. First joint of peduncle of antennula terminating exteriorly in a spine, second three times as long as the third; flagella short, hardly equalling the last two joints of peduncle. Antennal scale broad, regularly tapering, as long as antennular peduncle. External maxilliped falling short of the extremity of antennal peduncle. Feet slender, round; those of the third pair reaching slightly further than the external maxillipeds. Abdomen sharply carinate above, sides punctate, sculptured, protuberant parts rounded. Third to sixth segments with a spine at the postero-inferior angle. Telson narrow, acute, with a shallow groove on the dorsal surface.

Length.
38 mm.

Carapax.
9.5 mm.

Rostrum.
3 mm.

Fort Jefferson, Fla., Lieut. W. H. Jacques, U. S. N.

Is quite different from the two species *S. brevirostris* Stm. (*S. cristata* Saussure), and *S. laevigata*, Stm., before known from this coast.

PENEUS Latreille.

Peneus brevirostris, n. s.

Compressed, sutures of carapax well marked, carina with a sulcus on each side extending nearly to the posterior margin of the carapax; rostrum short, horizontal, apex a little depressed, scarcely exceeding the eyes, ten-toothed above, of which the first four are on the carapax itself, distal fourth smooth; below with two teeth near the tip. Flagella of antennulæ very short. Antennal scale about as long as antennular peduncle, laminate portion extending beyond the spine at the antero-lateral angle; flagellum longer than the body, spines at the base of the first two pairs of feet slender. Third pair of feet the longest, extending to the apex of the antennal scale. Abdomen compressed, fourth to sixth segments with a dorsal median crest. Telson short, regularly tapering to an acute tip, a deep and narrow longitudinal furrow above. Inner caudal lamella longitudinally bisulcate.

Length.	Carapax.	Rostrum.
42 mm.	10 mm.	5 mm.

Estero at Realijo, W. Coast of Nicaragua (salt water), J. A. McNiel.



MARCH 5, 1878.

The President, Dr. RUSCHENBERGER, in the chair.

Forty-one persons present.

The following papers were presented for publication:—

“Recovery of all the Faculties in a Pigeon from which the Cerebral Hemispheres had been removed.” By J. H. McQuillen, M.D.

“The Electric Constitution of the Solar System.” By Jacob Ennis.

A Hippopotamus Tusk.—Prof. LEIDY stated that in the Mozambique Collection of the International Exhibition, he had noticed a hippopotamus tooth remarkable for its size. It was an inferior canine, with a spiral turn, apparently from impeded growth, perhaps due to the loss of the opposing tooth. It measured 42 inches long in the spiral. The insertion was 16 inches, and the diameter 4 inches.

On Amœba.—Prof. LEIDY remarked that the first notice of an Amœba was of a large species, described by Rösel, under the name of *Proteus*, in the *Insecten-Belustigung*, Nurnberg, 1755. It was called by Linnæus *Volvox chaos* and *Chaos protheus*, and by Pallas *Volvox proteus*, and subsequently by Müller *Proteus diffluens*. As the latter generic name was preoccupied, Bory called the animal *Amiba*. Ehrenberg, in the *Infusionsthierchen*, describes a small species as *Amœba diffluens*, and refers all those previously described to the same. His supposed new and large species, which he describes as *Amœba princeps*, is really the same as Rösel's *Proteus*. The true name of this should be either *Amœba chaos* or *Amœba proteus*, the former according to strict rules of zoological nomenclature, though the latter would appear more appropriate as serving to perpetuate the name given by the discoverer of the first known rhizopod.

Black Barite from Derbyshire.—Prof. GEORGE A. KOENIG communicated the results of an examination made on a specimen labelled “Manganese from Derbyshire,” in the collection of the Academy. The mineral is jet-black in color, exhibiting metallic lustre. Lamellar structure without distinct forms. Strong cleavage. Cleavage pieces gave the angles of barite. Specific gravity = 4.345.

Boiled with hydrochloric acid the black color disappears, leaving a white substance. The analysis gave

BaSO ₄	=	96.40
Mn ₂ O ₃	=	3.10
H ₂ O	=	0.25
		<hr/>
		99.75

It presents an interesting illustration of how a comparatively small amount of one mineral may mask the most striking physical properties of a mineral species.

MARCH 12.

The President, Dr. RUSCHENBERGER, in the chair.

Nineteen persons present.

MARCH 19.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-two persons present.

MARCH 26.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-one persons present.

The following papers were presented for publication:—



a black spot on each side in advance of the pair of eyes. Prothorax narrower than the head, with a lateral conical point. Abdomen nearly twice the length of the head and thorax together; terminal segment rounded, and with a tuft of hairs on each side. Mandibles strong and black.

Expansive Force of Root Growth.—Mr. THOMAS MEEHAN exhibited a one-year-old peach tree with the stone yet attached. The stone had lost the usual power of dividing into two portions,



and remained tightly closed; but the plumule had forced its way through at the base, while the radicle appeared to have made its way entirely through the side of the hard shell. Mr. Meelian referred to other cases of a similar character, already recorded in the Proceedings of the Academy, notably those of the stolons of couch grass, which pushed through several potatoes, making a sort of necklace; and the case of the survey lawsuit where, by the thickening of the roots of a tree growing on a rock, the surveyor's mark on a tree trunk had, after many years, been elevated several inches, the effect of this growth being to lift a tree of many tons weight. This peach-stone case seemed remarkable not so much for its expansive as its penetrating force, which, as

suggested by Dr. Rothrock, may have been aided by an absorbent and solvent power.

The following papers were ordered to be published:—

THE ELECTRIC CONSTITUTION OF THE SOLAR SYSTEM.

BY JACOB ENNIS.

The zodiacal light, the aurora borealis, the corona of the sun, and the tails of comets, are all different forms of the same thing. They are electrical brushes, precisely the same as the electric brushes which in the night are seen to fly off from a highly charged electric machine. On the electric machine the electric fluid is developed by friction. On our great globe, on the sun, and on the comets, the electric fluid is developed by evaporation. Put a little saline water in a metallic vessel shaped like a watch crystal, then if heated, or if a hot pebble be dropped in the water, the vapor arising will be charged with the electric fluid. All the waters of our globe are more or less saline, and the ocean is very much saline, and the rising vapors are charged with electricity. A gill of water is changed into about 30 gallons of electrified vapor. All around our globe the average rainfall is about 36 inches a year. This shows the amount of water evaporated; and the amount of vapor and of the electric fluid rising daily high up in our atmosphere, is great beyond conception. A very small portion of the electric fluid comes down as lightning. The brilliant light and the loud explosions are simply indications of the resist-

But what repels this vast daily accumulation of electricity away from our planet off into empty space? The answer is that electricity alone can repel electricity; and in this case the repelling electricity is seen in the corona of the sun. The corona of the sun consists of brushes of electricity. They are so vast that they rise up visibly to our eyes at this great distance a million of miles. How much further they would be visible if our standpoint were nearer, we cannot say. They are caused there, as here, by the evaporation from the intense heat of the sun. They are so powerful as to drive the tails of comets, also electric brushes, in the direction away from the sun. They drive away from the direction of the sun our zodiacal light, and our aurora borealis, and aurora australis, all three of which must be regarded as the perpetual tail of our planet, in many respects similar to the tail of a comet; for the tails of some comets are so short and rare as to be either invisible or almost invisible at our distance.

Our auroral streamers and our zodiacal light are perpetual; they never cease, because evaporation never ceases. There is a zone all around our globe toward the Arctic Circle where the aurora borealis is seen every night. In Europe this zone lies in about 70 degrees of latitude, but in America it comes lower down, as far as about the latitude of 58 degrees. As we go northward from Philadelphia we see the northern aurora more and more frequently. It is easy in summer to go to Quebec, and from there in a steamer up the Saguenay River to Grand Bay and Chicoutimi, where very seldom a night passes without being cheered more or less by the electric lights along the northern sky.

The evidence is complete that an auroral display is a display of electricity. It runs along the telegraph wires, and messages have been dispatched and carried to their destination by the auroral power. During the display of September 2, 1859, it was estimated by telegraphic experts that "the intensity of this power was equal to that of 200 cups of Grove's battery on a line 230 miles long." I need not stop here to detail how telegraph operators have been stunned, how their apparatus has been melted, and how their work has been suspended by an electric storm on their wires coming from the aurora.

When there are extraordinary auroral displays they appear first in Europe and then in America; they travel from east to west around the globe like the dark cone of the night; they are on the dark

side of the globe, and the auroral streamers, sometimes 500 miles high, point away from the sun, like the tails of comets, driven by the sun's electric repulsion. This is illustrated by the hours in which they appear. In lower latitudes, say of 40 degrees, where the zone around the globe from east to west is very long, the aurora appears in the earlier part of the night, and the electric fluid is all driven off generally before midnight. But far to the north, where that zone is shorter, the appearances of the auroras are more often at midnight and later.

The following table shows the times of the appearance of many auroras in Canada, and other stations further north, at Carlton Fort, Athabasca, and Point Barrow, ranging from 48 to 71 degrees of latitude.

Hours.	No. of auroral displays.	Hours	No. of auroral displays.
6 P. M.	. . . 61	1 A. M.	. . . 328
7 " .	. . . 137	2 " .	. . . 267
8 " .	. . . 220	3 " .	. . . 240
9 " .	. . . 261	4 " .	. . . 183
10 " .	. . . 328	5 " .	. . . 133
11 " .	. . . 358	6 " .	. . . 81
Midnight	. . . 330		

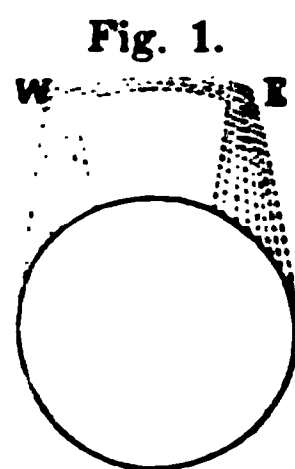
When MM. Lottin, Bravais, and their companions spent the long night of 70 times 24 hours at Alten Bay, in West Finmark, latitude 70, they saw 64 auroras, and perceived some half dozen

sons of extra large auroras, the tall streamers are seen to arise not only from the north, but all around from the east and the west, and less strongly from the south. Their upper limits seem to come nearly together a little south of the zenith in our latitude, and the near meeting of their tops forms a circle called the auroral corona. This circle is broken, or nearly broken, on the south side, because the streamers rising up from the distant southern latitudes are too far off to be plainly seen. While looking up to the centre of the corona we are really looking out of the far end of a tube—an auroral tube composed of electric streamers. These streamers seem to approach one another, and make the far end of the tube very small, but really they do not approach. Their apparent convergence is like the seeming approach of the two rails on a railroad when the eye can see them far away. These tall auroral streamers, which apparently converge and form the corona, must be several thousand miles high.

Now we can understand why the zone of constant auroras is far this side of the poles, and why the explorers and the whalers in the extreme north have to look southwardly to see the auroras. The polar regions on our globe are not in the direction away from the sun; their zenith is at right angles or perpendicular to the sun's radiations, and the solar electric repulsion drives all the terrestrial electricity away down to lower latitudes.

Now we can understand also why the earth's atmosphere extends so high. Mathematicians have declared that, according to Mariotte's law, it can extend upward only about 40 miles, but the passage of meteors through the air, and their bright ignition, prove that our atmosphere reaches as high as 200 miles. When we stand on an insulated stool charged with electricity, we know how our hairs all stand on end, and reach far out from our heads. Pith balls and tufts of down tied to the ends of threads on the prime conductor of an electric machine, all fly off at the full lengths of the threads. So it must be with the particles of air, only in a far greater degree, because they are so much lighter. The atmosphere, especially its upper surface, is like the prime conductor of an electric machine. This great machine rotating in the sun's rays, is constantly receiving an inconceivable amount of electricity from evaporation, and it must necessarily lift the top of our atmosphere far up—we cannot tell how high.

The Zodiacal Light.—Now first we can understand also the cause of zodiacal light. At the belt of calms in the equatorial region, where the trade winds meet from the north and from the south, there is much evaporation, and as the warm, moist air rises, the vapor is condensed, and it descends in rain. Some, though comparatively little, of the electricity comes down as lightning. During three rainy seasons within the tropics, I heard and saw much thunder and lightning among the clouds, but I never heard of a lightning stroke reaching the ground, though such instances may possibly have rarely occurred without my knowledge. Therefore on the equatorial zone the electricity must accumulate on the top of the atmosphere. This it must the more naturally do because above the unstable strata of the atmosphere, which moves north and south, there is a much taller stable stratum which remains always in the same latitudes. On this curious subject see the latter part of my paper on Meteors, in the Proceedings of the American Association for the Advancement of Science, for 1871. This accumulation of electricity on the equatorial region must meet the same fate as the accumulations near the polar regions. It must be driven off by the solar electric repulsion, and point with tall streamers away from the sun and form the zodiacal light. The zodiacal light has the same color and appearance as a large streamer of the aurora borealis, being brighter below and paling off slowly to the top, the point above where it fails to impress the



The adjoining figure shows a section at the equator of our globe and the departing streamers which form the zodiacal light, the morning or eastern one at E., and the evening or western one at W. At the equator on clear nights they are seen to be continuous by a faint arch all across the sky. The great authority on this subject is the work of Rev. George Jones, Chaplain in Commodore Perry's Expedition to Japan, in 1853-5, printed by the U. S. Government in 1856.

It may be thought that the electric repulsion from the sun should be seen on an ordinary electrometer. But our electrometers are deeply immersed in the bottom of our electric atmosphere, and this being near, overpowers the distant influence from the sun, the same as our moon is controlled by the feeble gravity of the earth, and not by the more powerful gravity of the sun. The sun's electric repulsion is seen in giving a general external direction to the earth's electrical envelop, and not in causing small differences among interior objects.

The Corona of the Sun.—At total eclipses a whitish irregular ring, nearly as broad as the sun's diameter, appears around the sun. It has been compared with the "glory" which in catholic pictures appears around the heads of saints. This is the corona. It is doubtless an effulgence, a constant streaming forth of electricity, like the aurora borealis, or like the zodiacal light, from every part of the sun's surface. It cannot be an atmosphere except in its very lowest border, for some comets have passed through it with their speed unaltered and their bodies unaffected. This impunity could not have happened to such large and extremely rare bodies, with such velocities, through any atmosphere. As it cannot be an atmosphere, we can think of it as nothing but an outflow of electricity, an electrical brush, or as thousands of them united. But what can be the source of this outflow of the electric fluid? We must refer it to the same cause as that from our earth—evaporation. As evaporation from the sun is millions of times greater than from our earth, so the evolution of electricity may be in proportion. On earth the best image of the sun is the crater of a volcano, and no displays of thunder and lightning are equal to those seen and heard in the ascending volcanic emanations. Among our electric machines there is none so powerful as the one which

goes by evaporation. The vapor most highly charged with electricity issues from many small orifices in the sides of a tube. The electric fluid in this case has been supposed to arise from the friction of the vapor against the sides of the orifices; but this conjecture is loose and unsatisfactory. Even if it be true in whole or in part, there is something like it in the sun. The great mass of the sun consists of molten, liquid matters, with a specific gravity one-fourth heavier than water or ice. This is the great source of light and heat. Around this is an envelop of flames from 2000 to 4000 miles high. This height is ascertained by the depressions of the spots, which are solids partially cooled, and floating like cakes of ice on water. This tall envelop of flames is the so-called photosphere, having suspended in it many different solar elements, and the thousands of their fixed spectroscopic lines are dark, because the chief light of the sun comes from the incandescent liquid below. In that liquid chemical action is going on with inconceivable force, and its products are not only heat and light, but red vapors. From the vast amounts of some of these vapor jets, we must suppose that large bubbles of vapor, several hundred miles in diameter, are formed thousands of miles down in the interior of the sun. They must be subject to enormous hydraulic pressure, and in the same proportion they must be ejected upwards with enormous velocities, some more and others less, depending on their sizes and the depths from which they come. Some rise

which there is not the least appearance. Hydrogen has only four fixed lines in its spectrum, but Prof. Young has seen nearly 500 in the red vapors of the sun. Probably, therefore, it is a complex vapor consisting of several elements; and, like our vapors here, it may be a source of electricity. Like a hydro-electric apparatus, it may also generate electricity by the friction as the huge bubbles rise up so swiftly from the deep interior of the sun.

In appearance and in action there is a perfect identity between our aurora borealis and the corona of the sun. The lower portions of both are white without any variations of tint. Above their bases begin their radiations—tall streamers reaching upwards. The streamers are brightest below, and gradually pale off towards their tops, and these tops vanish away in space so as to be undetectable. In both the largest and brightest streamers reach out the furthest, because they are the fullest and most copious jets or branches of the electric fluid. Taking them altogether the line of their contours above is a very broken jagged line. Hence around the sun the contour of the corona is often not circular but trapezoidal and otherwise irregular. Between the bright radiations of the corona there are darkish lines extending outwards, not really dark, but faint spaces less brightened by the rays. Wider spaces between the rays are called “rifts;” the same as there may be deep depressions, nearly vacant spaces, in our auroras between the tall streamers. These radiations and rifts in the solar corona have been photographed.

The same rapid changes in our aurora are seen in the solar corona. Sometimes the corona is large, and then it is so bright that the eye can scarcely endure its splendor. It then extends far outward, and is very irregular in its exterior contour—the streamers in some places are seen to rise a million of miles high. At other times the corona is small and pale, and without radiations, or such radiations as are easily perceptible. Then its form around the sun is circular, and nearly even in contour. Prof. Neumann, describing the total eclipse of 1870, said, “Instead of the gorgeous spectacle I witnessed in the total eclipse of 1869, I saw only the most insignificant corona.” Speaking of the “great changes in brilliancy,” he says, “the corona of 1869 seemed to me many times more brilliant than that in 1870.” “The light of the latter seemed everywhere as soft and diffused as the zodiacal light.” Still even then, other observers, probably with clearer

skies, could detect rays, as Prof. Eastman and Capt. Tupman. Professor Harkness, writing of the eclipse of 1870, said, "I do not think the corona more than half or two-thirds as extensive as that I witnessed in 1869. On that occasion it had a well-marked trapezoidal form, but this time it seemed to me more nearly circular." "Otto Struve, observing at Leipsic, in 1842, found the corona so bright that the naked eye could scarcely endure it. Mr. Airy has been fortunate enough to witness several total eclipses, and he testifies that the corona was much brighter in some than in others. The experience of the officers of this observatory is the same." Here the aurora borealis shows precisely the same differences at different times. It may be large, bright, distinctly radiated, with a rough, uneven contour; or it may be small, faint, without radiations, and perfectly circular on its top.

Not only from year to year, but even during the brief period of a total eclipse, the corona of the sun changes before the eye. In this respect also it is identical with our aurora borealis. Streamers in both shoot up almost with the velocity of light. I have seen in one aurora strong undulations, like white clouds, fly up from our northern horizon to the auroral corona, south of the zenith, in the fraction of a second. The great comet in 1843 passed around the sun in about two hours, and its tail, more than 100,000,000 miles long, must have swept around through an arc of 300 degrees in that short period. It could not have swung around like a stiff

ten seconds, the left and lower parts, B to C in the figure, were the brightest and the largest; and so they remained until near the end of the totality, when the part, D, in the right lower quadrant, almost if not quite rivalled them. The ray, D, did not enlarge suddenly, but very gradually indeed. The upper part of the corona was throughout the faintest. The extreme right was also faint until quite at the end of totality, when it brightened a little. No part increased in brilliancy without extending itself further from the moon at the same time, so as to become a more or less pointed ray." Just, in fact, as it should do if it were the action of electricity. A copious outgush of the electric fluid would enlarge and brighten the ray and extend it far outward as an electric brush. The evidence is strong that the corona of the sun varies, like the aurora borealis, not only from year to year, but even during the short space of a total eclipse.

I have now brought together the chief facts about the corona of the sun. They are like those of the aurora borealis. The aurora is well known to be electric. And all the facts of the corona are perfectly explained by the same theory. Regarding the corona as being a great electric brush, we have also an explanation why the aurora and the zodiacal light point, like the tails of comets, away from the sun. They are driven off by the sun's electric repulsion. If the sun's electric brush extends off on every side a million of miles from our stand-point, then if we stood nearer, say at the orbit of Mercury, we would likely be able to see them extend twice as far. The power, the repulsive force, of such an enormous mass of electricity is beyond our estimation by any reasoning, *à priori*. Facts alone must teach us how far its repulsive force may extend, and such facts we see in the diurnal and in the eleven years' periodicity of the aurora, and in the diurnal periodicity of the zodiacal light. Such facts we see much more impressively in the directions of the tails of comets driven off by the mighty repulsion of the solar corona. To the comets we will now attend.

The Tails of Comets regarded as Electric Brushes.—Here on our earth some materials evolve much more electricity than others. Tin, zinc, and mercury, duly mixed, are found to be the best for friction machines; and a like selection of acids and metals is necessary for the galvanic battery. The materials of the sun and of the comets are very different from ours, and, therefore, they evolve much greater quantities of electricity. The fixed lines

in the solar spectrum are innumerable, and indicate hundreds, probably thousands, of simple elements in the sun. Only about a half dozen of them are terrestrial, and some of these, such as the iron, may have fallen in the sun as meteors. Thousands of solid meteors strike our earth annually, and the iron ones occasionally weigh thousands of pounds. More and heavier meteors must fall in the sun. The materials of comets we know to be very different, because they are such light bodies, and they are easily evaporated and dilated by solar heat. A comet at a distance appears large, but nearer the sun it seems smaller, because much of its mass is so dilated by solar heat as to be invisible. As the cometic and the solar elements are so different from the terrestrial, it is not strange or singular that their evaporation gives out more electric fluid than the saline waters of our ocean.

Comets present appearances so different from the other celestial bodies, that they have been a terror to the world, and even scientific men have regarded them as totally different in their natures from the other stars. But they are precisely similar to the other stars; the only difference being that they carry some few ordinary principles to excess. Their bodies are solid and very small; in modern times they have repeatedly occulted the stars. Their atmospheres are unusually large. They are easily evaporated and dilated by the sun's rays; and in this evaporation they evolve unusual amounts of the electric fluid. This is all. These few

radiance of the sun. It is chiefly their own independent luminosity springing from electric excitement.

This light is seen to arise from the side toward the sun, and, therefore, from the most heated and evaporated side. It rises narrowly fan-shaped; very narrow and bright below, and spreading and paling upwards through the cometic atmosphere. It is then, by the repulsion of the sun's corona, driven backward all around like a fountain away from the sun, and it forms the tail, which generally spreads and becomes fainter, until it is lost by dispersion. Its resemblance to our auroral streamers is then complete. In the summer of 1874, when Coggia's comet appeared in our northern horizon, with its large, broad tail projecting straight upward, I was on Mount Desert Island, far up the coast of Maine, where the auroral streamers rise beautifully almost every night. The rise of those streamers, and the rise of the comet's tail, were identical in every particular. Both were of the same color and tint; both were brighter below and gradually faded off upwards. Their tops had the same indefinite ending, and both plainly lengthened and shortened while attentively watched. Tremulous waves ran upwards through them both—whitish, cloud-like appearances—as if they were special gushes of the electric fluid hastening to escape, and carrying out the tops of both to a further distance. The same cloud-like impulses pass through our artificial auroral tubes. But they are plainer to our view in our near auroral tubes, less plain in the aurora brushes, and faintest of all in the tails of comets. These three gradations depend on the distance. I remarked that the general brightness of the comet's tail, so many million miles off, was about equal to that of the aurora borealis, so comparatively near; proving that the amount of the electric fluid from the comet must have been inconceivably the greater.

It is a cardinal fact that the tails of comets do not occult the stars. If their tails were vapors of any kind, the occultations would be decided and constant; therefore the apparent vapor rising up from the sunny side of the comet is really the electric fluid.

The tail of a comet must be a hollow tube, because it springs from the sunward side, and falls back around on every side, like the waters of a fountain, and its own self-repulsion hinders it from coming together. Hence there appears a dark line through the centre of the tail, because from there, less electric light meets the

eye than from the borders whose edges are turned towards us. The dark line cannot be the shadow of the nucleus, because a shadow cannot curve as did Donati's comet.

The fan-shaped jet of light arising through the front of the comet's atmosphere is not always steady, but breaks out at different places, "as from points of least resistance." Hence the tail is sometimes described as unsteady, and to "sway to and fro like a willow branch."

Auroral arches arise over our northern horizon and hover there for a while, occasionally two or three above one another, and then dart off in streamers. Exactly the same luminous arches rise in front of the comet, and the streamers then become the tail. But there is this difference. The streamers of the aurora rise from the convex side of the arch; those of the comet are driven backward by the solar corona, and seem to depart from the concave side.

The head of a comet is solid, with perhaps some exceptions, and the bright glow of light all around it is called the nucleus. The broader and paler atmosphere is called the coma or hair. But some writers call the tail the coma. In the coma or atmosphere there may be clouds, as in our own; and these clouds have been seen to be lit up by the electric passage. A comet may have many tails, as many as six. This is because in the solid nucleus there may be many points of least resistance, out of which the streams of vapor and electricity flow.



producing power, of the materials of other celestial orbs, we are perfectly unable, *à priori*, to tell. All that we know is from what we see.

The electric composition of these great tails becomes manifest from the way they go around the sun. Some great comets go around the sun in about two hours, as that of 1843, the tail all the while pointing away from the sun. Its outer end could not have swung around like a stiff lever through a space of 700,000,000 miles in so short a time. That would have been inconsistent, as I have already said, with the laws of matter and of motion. The tail must, therefore, have darted out continuously from the comet as an electric brush, and it must have been repelled in its direction away from the sun by the sun's more powerful electric mass. There is something clearly defined and decided in the huge tail pointing away from the sun in its approach, and then apparently swinging around with the velocity of lightning, and on its departure pointing away from the sun again. The electric theory of the constitution of the solar system explains the wonder clearly and easily, and nothing else can.

Evaporation explains why the tails of comets have become shorter on successive visits. The tail of Halley's comet was first described as being excessive. In 1682, it was 30° in length; in 1835, its greatest length was only 20° . For the first two months in 1835 it had no tail. It began on October 2d. On the 5th, it was 4° or 5° long. On the 15th, it had gained its greatest length, 20° . On the 29th, it was only 3° . Afterwards, at its perihelion passage, it had no tail. The explanation is that all these elements, whose evaporation evolved the electric fluid, had turned into vapor before perihelion, and then there could be no further evaporation with evolution of the tail. But a condensation of much of that vapor must again take place in the cold outer region away from the sun; and this recondensed material must furnish another tail on its next visit—a smaller tail, however, for a portion of the vapor must be carried away with the electric fluid, and scattered into distant space. When comets have no tails, it may be that they have never possessed any of those peculiar elements on whose evaporation the tail depends, or that by repeated visits to the sun all their powerful electric elements have been lost.

The electric theory explains the various forms of the tail. That of 1843, which was more than 100,000,000 miles long, appeared

like a straight cylinder of light with very little difference in thickness through the whole length. I remember it well. It was very near the sun, whose large electric mass and powerful repulsion drove off the smaller mass in right lines. The sun was the great prime conductor fully charged, and the comet was only like a small highly-charged pith ball. The tail of Coggia's comet, being much further from the sun, was more spreading and fan-like. On account of greater distance, the sun's force was less, and the self-repulsion widened the tail. The tail of Donati's comet was spreading on account of the distance from the sun, and gracefully curved. This curving was because the comet was moving nearly at right angles to the direction toward the sun, and as the tail was not repelled out rapidly, it fell behind the comet in its progress. In our figure S represents the sun, and C the comet moving in the direction of the arrow, and getting in advance of the extreme end of its tail.

Fig. 2.

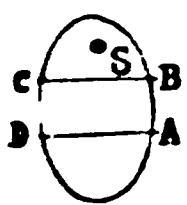


Our theory tells why some comets have been split in two or three parts, and finally into thousands of meteors. Although they are solid bodies, their cohesion is very slight. With a cotton string I tied in a bundle a handful of the downy tufted seeds of the milk-weed, *Asclepias incarnata*, which is abundant here. The other end of the string I connected with the prime conductor of a large electric machine. On turning the crank my bundle was soon dissipated, torn by electric repulsion into many parts, which

.S

ance the distance between them was 160,000 miles, and by their next return that distance had grown to be 1,250,000 miles. On the night of the 13th and 14th of November, 1857, the officers of the Observatory at Washington counted 3000 meteors in an hour. Professor Newcomb calculated that on an average every meteor occupied as its own territory 900,000 cubic miles. The gravity of the sun could separate them only in one direction; but their nearly even diffusion every way seems like the work of electric repulsion. The meteors of the August stream are still more widely dispersed.

We can now see how comets may shorten their periods without the theory of a terrible ponderable resisting medium existing everywhere. That is a most violent theory, and threatens to break down the entire solar system on the sun. Let the curve A, B, C, D be the elliptic orbit of a comet, and S the sun in a focus. Let the comet on its approach move any distance from A to B in a day, and an equal distance from C to D in the same time on its departure. The electricity of the sun repels the comet, because both are clothed with electricity; the same as a charged prime conductor repels a charged pith-ball. For simplicity of conception let the repulsive influence from the sun move just as fast as the comet in these two regions of its orbit; that is, from B to A, and from C to D, in one day. Then on its approach the comet must suffer resistance in moving from A to B; but it finds no influence at all in moving from C to D. The same principle must apply nearly all around the orbit. Whatever the difference between the velocity of the comet and that of the repulsive force from the sun, it must remain true that from aphelion to perihelion the comet must lose more velocity from the electric repulsion of the sun than it gains by that repulsion, in moving from perihelion to aphelion. Therefore, upon the whole, the comet must suffer resistance from the electric repulsion of the sun, and its period must be shortened. This resistance is all the more effective from the great size and small mass of the comet. Encke's comet, which gave rise to the "resisting medium" theory, is highly electric, as is shown in the drawings of Professor Asaph Hall, made on its return in 1871, printed in 1872. For one, I am happy in being relieved from the dangerous, cumbersome, and highly improbable "resisting medium" theory.



It has before been surmised by some that the solar corona is electric. Others have thought that the tails of comets are electric. The aurora has been proved to be electric. But no one has conjectured the origin of these electricities, except that evaporation has been regarded as one of the origins of terrestrial atmospheric electricity. No one has assigned evaporation as the cause of the solar corona. Sir John Herschel believed the tails of comets to be vapors of some kind, raised by the heat of the sun, and driven away by some unknown repulsion from the sun. But his vapors were not the electric fluid, and his repulsion was not electric repulsion. See his "Outlines." No one has said that the zodiacal light is electric, and that this and the auroral streamers, always like comets, point away from the sun. No one has regarded all these phenomena as emanating from a common cause: the solar heat causing evaporation. No one has supposed that the far distant solar corona, by mere electric repulsion, drives off the tails of comets, the auroral streamers, and the zodiacal light. A highly-charged electric machine affects a delicate electrometer far off on the opposite side of a wide room; but this wonder, until now, was not fruitful in originating our theory. Now, first, all these distant facts have been brought together, and they are seen to form a harmonious system. A new spiritual influence is found to pervade our entire solar system. If, in this system, the solar repulsion drives off the tails of comets 120,000,000 miles with nearly the

APRIL 2.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-six persons present.

The death of Dr. Charles Pickering, a correspondent, was announced.

Toilet Habits of Ants.—Rev. H. C. McCook stated that the agricultural ant—and the remark applies to all other ants of which he had knowledge—is one of the neatest of creatures in her personal habits. He thought he had never seen one of his imprisoned harvesters, either *barbatus* or *crudelis*, in an untidy condition. They issue from their burrows, after the most active digging, even when the earth is damp, without being perceptibly soiled. Such minute particles of dirt as cling to the body are carefully removed. Indeed the whole body is frequently and thoroughly cleansed, a duty which is habitually, he might almost venture to say invariably, attended to after eating and after sleep. In this process the ants assist one another; and it is an exceedingly interesting sight which is presented to the observer when this general “washing up” is in progress. In the evening, when the gas-lamp upon his table is lit, and he had leisure from professional duties to watch his insect friends, he had many times kept them under notice for protracted periods. They crowd against the glass, and gather in groups upon the earth close up to it and cleanse themselves, cleanse each other, and sleep. The first operation is conducted as follows: The ant to whom the friendly office is being administered (the cleansed, she may be called) is leaning over upon one side as we begin the observation. The cleanser (as we may name the other party) is in the act of lifting the fore leg, which is licked, the mouth passing steadily from the tarsus up to the body; next, the neck is licked, then the prothorax, then the head. The cleanser now leaves, and the cleansed begins to operate upon herself as will be described hereafter. This process may be seen throughout the entire group. We take another couple; the cleanser has begun at the face, which is licked thoroughly, even the mandibles being cared for, they being held apart for convenient manipulation. From the face the cleanser passes to the thorax, thence to the haunch, and so along the first leg, the second and third in the same manner, around to the abdomen, and thence up the other side of the ant to the head. A third ant approaches and joins in the friendly task, but soon abandons the field to the original cleanser. The attitude of the cleansed all this while is one of intense satisfaction, quite resembling that of a family dog when one is scratching the back of his neck. The insect stretches out

her limbs, and as her friend takes them successively into hand, yields them limp and supple to her manipulation; she rolls gently over upon her side, even quite over upon her back, and with all her limbs relaxed presents a perfect picture of muscular surrender and ease. The pleasure which the creatures take in being thus "combed" and "sponged" is really enjoyable to the observer. He had seen an ant kneel down before another, and thrust forward the head, drooping, quite under the face, and lie there motionless, thus expressing as plainly as sign-language could her desire to be cleansed. He understood the gesture, and so did the supplicated ant, for she at once went to work. If analogies in nature-studies were not so apt to be misleading, one might venture to suggest that our insect friends are thus in possession of a modified sort of emmetonian Turkish bath!

The acrobatic skill of these ants, which had often furnished him amusement, was fully shown one morning in these offices of abjection. The formicary was taken from the study where the air had become chilled, and placed in an adjoining chamber upon the hearth, before an open grate fire. The genial warmth was soon diffused throughout the nest, and aroused the occupants to unusual activity. A tuft of grass in the centre of the box was presently covered with them. They climbed to the very top of the spires, turned around and around, hanging by their paws, not unlike gymnasts performing upon a turning-bar. They hung or clung in various positions, grasping the grass-blade with the third and fourth pairs of legs, which were spread out at length, cleansing their heads with the fore legs or bending underneath to comb and lick the abdomen. Among these ants were several pairs, in one case a triplet, engaged in the cleansing operation just described.



efficiency for service. Not only the fore pair, but also the other legs are passed, as above described, through the mouth. The second and third pairs are also and oftener cleansed by the fore legs as follows: the ant throws herself over upon her side, draws up the middle and hind legs, which are interlocked at the tarsi, and then, clasping them with one fore leg, presses the other downward along the other two. The fore legs alternate in this motion. When the legs of one side are cleansed, the ant reverses her position, and repeats the process. When the antennæ are cleansed they appear to be taken between the curved spur at the extremity of the tibia and the tibia itself, as one would clasp an object between the base of the thumb and the hand, and are drawn toward the tip of the flagellum, evidently with some pressure. He had thought that he could notice this spur also used as a brush or scraper in the general application of the fore leg to the body. It seems to have an articulation at its junction with the tibia.

The cleansing of the abdomen places the ant in a grotesque attitude. The hind legs are thrown backward and well extended, the middle pair nearly straight outward from the thorax, and less extended, so that the body is able to assume a nearly erect posture. The abdomen is then turned under the body and upward toward the head, which is at the same time bent over and downward. The body of the ant thus forms a letter C, or nearly a circle. The fore feet have meanwhile clasped the abdomen, and the work of brushing has begun. The strokes are directed upward toward the apex of the abdomen, and the foot passes around and beneath the under part, which is now toward the sternum. The apex is frequently licked by the tongue, and the feet are occasionally passed through the mouth (not simply between the mandibles), after which they again are applied as before. Evidently moisture is conveyed from the mouth and rubbed upon the abdomen. He had so frequently observed this action that he could hardly be mistaken in the glossy appearance which showed the presence of moisture upon the surface. Occasionally the leg is rubbed over the head after being drawn through the mouth, and so again to the abdomen. Usually the abdomen is held a little distance from the sternum, but he had seen it pressed up close against the breast, while the outer (upper) part was being cleansed. One ant was seen cleansing its abdomen while hanging by the hind legs from the roof of the formicarium. The abdomen was thrown up and between these legs, just as a performer on the turning-bar throws his body on legs upward and between the arms. The head was reached upward from below to the apex of the abdomen, while tongue and fore feet were engaged upon it in the usual way.

The amount of time devoted to these toilet duties is very great in imprisoned ants, but is probably not so great in a state of nature. No doubt with ants, as with men, an artificial condition of society gives inducement to a larger devotion to personal

appearance. He had not been able to give them much attention during the day; but when they are transferred to the neighborhood of register or fire-place, and thus are made unusually comfortable, they at once begin their ablutions. Invariably, at night, when the gas-lamp is lit and placed near the glass formicaries, the heat and light, both of which appear to be grateful to them, tempt them out, as already stated, and they begin operations. So also after eating, and when awaking from sleep. In short, whenever they are in a particularly comfortable state they express their satisfaction by making their toilet.

Notes on Acer rubrum.—Mr. THOMAS MEEHAN observed that polygamous plants were defined as those which had hermaphrodite and male and female flowers on the same or separate plants, and, in some of our text-books, the red maple was given as an illustration. But though the red maple had full-sized anthers in the early stage of the female flowers, the stamens were never fully developed, or were polleniferous, so far as his experience extended. According to his observations, the casual observer might be pardoned for supposing what are really but female flowers are hermaphrodite; for, on the bursting of the petals, the centre of the flower seems a mass of perfectly formed anthers. At this particular stage of the inflorescence, the appearances in the male and female flowers are exactly alike, except that in the female flowers the apices of the two pistils are visible in the centre of the mass of stamens in the one case, while they are wholly absent in the other. But, with the expansion of the petals, all growth in the stamens ceases in the pistillate flowers. They remain in this unfinished condition, while the pistils continue to elaborate and the ovary to enlarge.

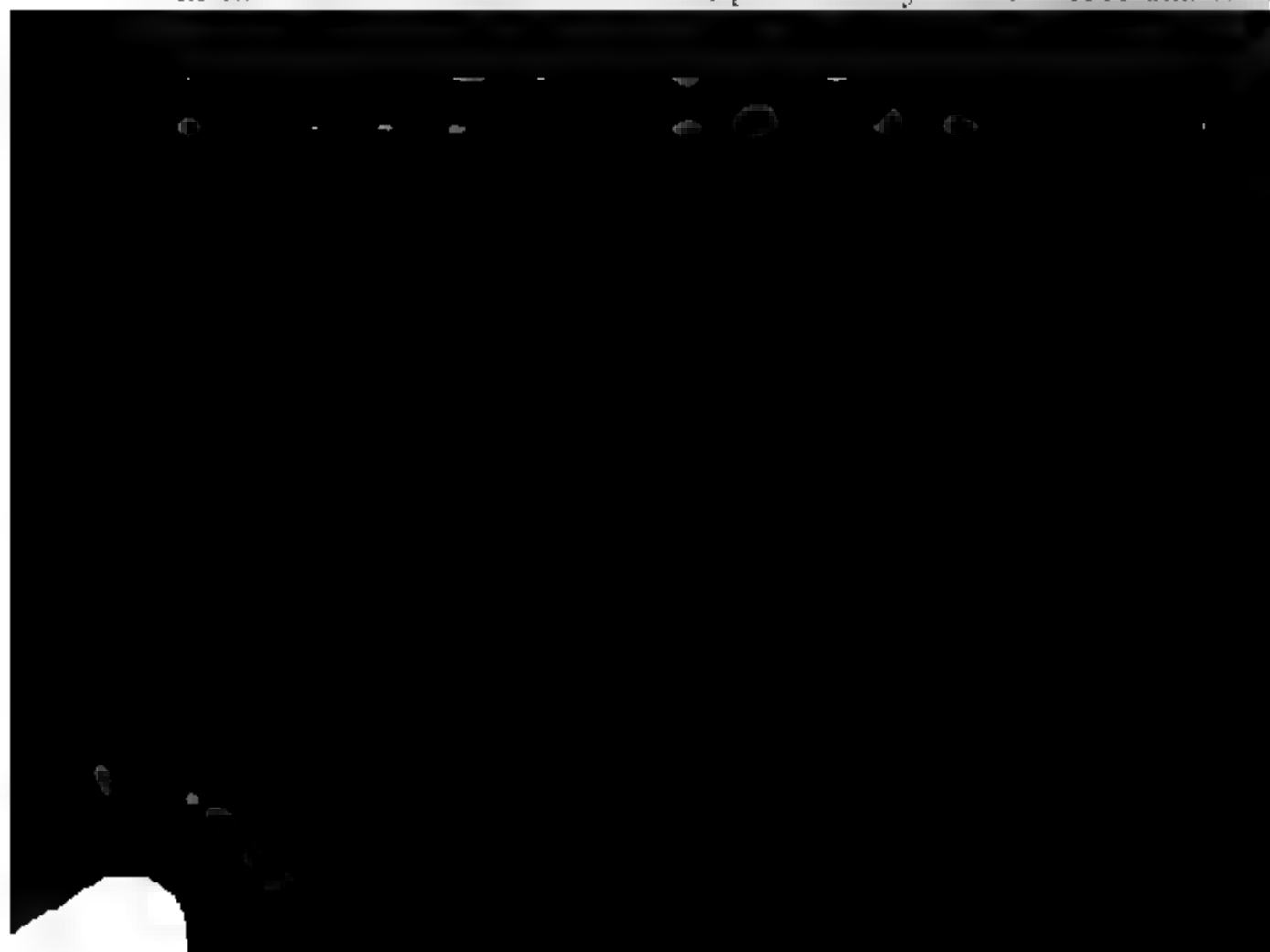
dasycarpum, correspond, but in the permanency of the sexual character the silver maple departs here. It is not uncommon to find trees originally female, at some time sending forth male branches. So far as his observations have gone, no male tree ever produces female branches, nor does a branch once producing male flowers return to a female condition. Notes were made to ascertain whether the mere vegetative vigor or the early or lateness of flowering had anything to do with the sexual conditions; but though some trees were nearly a week later in opening their flower buds than others, and some trees were weak and starved looking, while others were vigorous, these varieties were as equally divided among those of one sex as the other.

It was further noted that the male flowers were fragrant, while the female flowers were inodorous, in this respect similar to the willow. The male flowers of the willow are eagerly sought for by bees which collect pollen from them. So far he had found no bees visiting these, though in the warm April days some of the last to be in blossom attract small sand wasps to them. It is probable that bees may under some circumstances visit the flowers, though under this season's observation they had not done so. As it appeared that in many cases bees and insects were attracted to flowers by their odor, and that the visits resulted in cross fertilization, it was worthy of inquiry by those engaged in this special study what purpose was served by this sweet attraction in cases like this of the maple and willow. Can it be that the red maple or its ancestors were once truly hermaphrodite, and that when the sexes were separated, and the species become anemophilous, fragrance remained as the hereditary remains of a past usefulness?

The following papers were ordered to be published:—

THE BASILICA SPIDER AND HER SNARE.**By REV. HENRY C. MCCOOK.**

In the month of July, 1877, I was encamped upon the hills of the Colorado River, a few miles southwest of Austin, studying the habits of the Agricultural and Cutting Ants of Texas. A limited portion of time was given to observations upon spiders, in the course of which the object of this sketch was discovered. Her snare was hung about two feet from the ground, upon a bush which stood in the midst of a grove of young live-oaks. This snare had the composite structure imperfectly represented in Fig. 1. The general form of the snare was that of a pyramid, the upper part of which, *r*, was a mass of right lines knotted and looped, and crossing in all directions. Within this mass was suspended an open silken dome, *d*, constructed of a vast number of radii, crossed at regular intervals by concentrics after the manner of the snare of the common orb-weaving garden spider. The radii were about $\frac{1}{8}$ th of an inch apart at the bottom or circumference of the dome. The concentrics extended entirely and with equal regularity to the summit. They did not cross the radii in circular lines, but presented that notched appearance which is observed in the webs of some orb weavers, particularly those whose snares



destroyed, after it had been sketched, in order that the architect, herself one of the most beautiful of her order, might be collected in the cabinet. The species has been named *Epeira basilica*, the architecture having suggested the dome-bearing temples of earlier Christians of the Eastern Church.

Fig. 1.



Figure of *Epeira basilica*, a species of the genus *Epeira*, from the collection of the Philadelphia Academy of Natural Sciences.

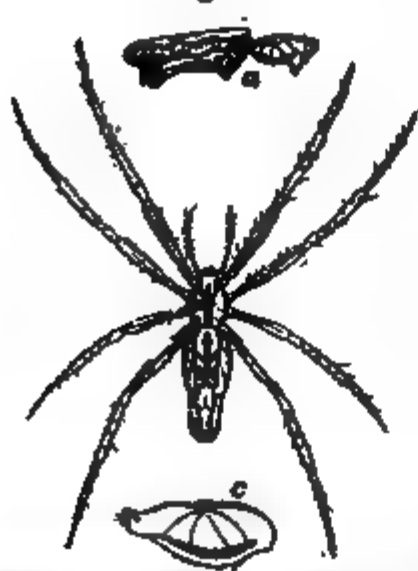
It would be an interesting study to the architect of human habitations, to uncover the principles upon which this silken basilica was reared. He would doubtless find admirable adaptation of means to ends; he would be likely to meet methods quite familiar to himself, and perhaps stumble upon some of which he is yet ignorant. He certainly would have occasion to marvel that a structure so stable could be wrought out of such fragile material as spider silk, and that the delicate dome could be so poised in

the midst and by the help of silken threads as to preserve its perfect form. Perhaps he would rise from the study with a higher appreciation of the qualities and character of despised *Arachne*.

Nor would he find the creature herself unworthy of admiration as she hangs inverted within and just below the summit of the dome. The term beautiful is rarely associated with individuals of her order, but it may properly be used in this case. The fore part of the body, cephalothorax, is of a golden-yellow color, bordered and marked with blackish bands. The legs are a delicate green, having the thighs marked by blackish longitudinal bands,

and blackish annuli at the joints. On the back of the abdomen the colors within the blackish marginal lines are as follows: At the base, next the cephalothorax, a snowy white; the middle lobes are a light yellow, the lower lobes and the cruciform figure (showing white in the illustration), are a golden-yellow. The bands and markings on the side of the abdomen, a view of which is given at *a*, Fig. 2, are in the following order from the top, viz., crimson, white, dark-green with light-green edges, blackish to dark green, yellow. Even

Fig. 2.



E. tridactylus, as described at Pr.

a perfect link between the orb-weaving and the line-weaving spiders in the characteristic spinning-work of the two groups. The main object of this paper is to exhibit this fact.

Some of the orb-weavers (*Orbitelariæ*) have associated with their geometrical snare the characteristic snare of the line-weavers

Fig. 4.



Epeira globosa.
Female. Length,
2½ inch.

(*Retitelariæ*), which is a mass of right lines knotted together at various angles, and forming at once the home and the snare of the animal. The web of the labyrinth spider, *Epeira labyrinthea* Hentz, is an example of this, common to at least our Eastern States. Another of these composite webs is that of the *Epeira globosa*, Keyserling, Fig. 4, a description of which is appended to this paper.¹

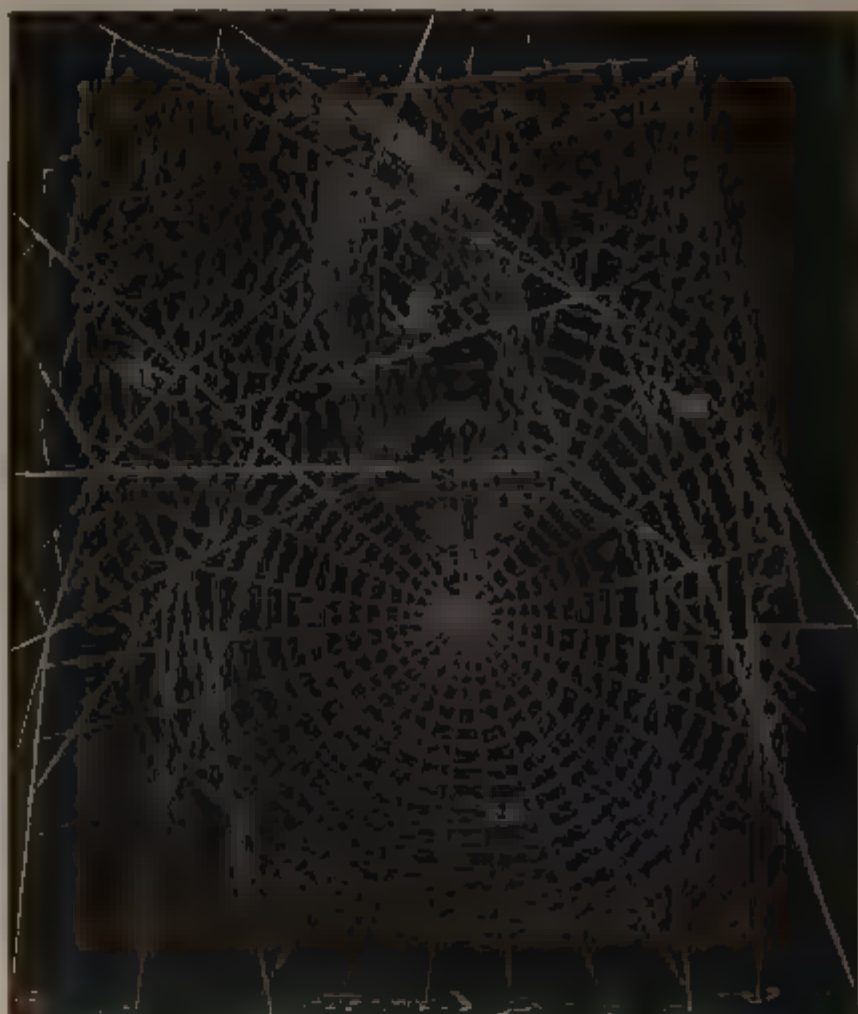
The curious manner in which the snares of the *Orbitelariæ* and *Retitelariæ* blend may be sufficiently shown by Fig. 5, which illustrates the spinning-work of this spider, as compared with Figs. 1 and 6.

It will be remembered that the simple characteristic web of the orb-weaver is the vertical geometric orb represented at Fig. 5, o. In that example, however, there is a slight variation, as seen at f, in a break in the radii, leaving what is known as a free radius. The bell-shaped den of thick white silk, d, within which the spider constantly dwells, is not peculiar to this species; most of the orb-weavers have a similar tent, or some floss-upholstered crevice, hole, or leafy nest, within which they conceal themselves frequently or habitually. But *Epeira globosa* exhibits two other remarkable additions to the simple orb. First, there is an open but quite distinct tube, g, attached to the mouth of the den, d, from which it reaches almost to the centre, c, of the orb to which the free radius is fastened. The free radius runs through or along the "floor" of this tube, is continually kept taut, and is clasped at the upper end by the fore feet of the spider. An insect struggling in the orb thus communicates the motion to the vigilant creature in the den, who dashes along her covered gangway, g, to seize her prey. This gangway is at times imperfect, shortened, or even wholly omitted, but is frequently found as in the figure, which was drawn from nature. In this bell-shaped den and connecting tube one may see a germ or modification, or suggestion,

¹ See Proceedings Acad. Nat. Sciences, Phila., p. 201, 1876.

of the dome-shaped sheet-web of the *Linyphioidæ*. See Figs. 6 and 7.

Fig. 5



Sheet of *Epeiridium*. J. Den & Gangway, in Mass of right stick in eye. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 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2173. 2174. 2175. 2176. 2177. 2178. 2179. 2180. 2181. 2182. 2183. 2184. 21

We have thus our first distinct connecting link between the spinning work of orb-weavers and line-weavers, established at the typical web of the latter as shown especially in the snares of the family *Theridioidæ*.

The second and most noteworthy link, which indeed constitutes in the web of *E. basilica* a complete inter-blending of the groups, is at the snares of the *Linyphioidæ*. The genus *Linyphia* is one of the largest and most important genera of the line-weavers. In order to show the steps by which the two groups approach each other in habit, some explanation of the spinning work of the *Linyphia* is necessary. Their webs differ from the *Theridioidæ* substantially in the addition of a sheet-like web to the web of right lines; indeed the right lines take a subordinate or subsidiary place, and the sheet appears to be the real snare. There are three common variations of form. First, a plain sheet of thin silk, attached to

FIG. 6

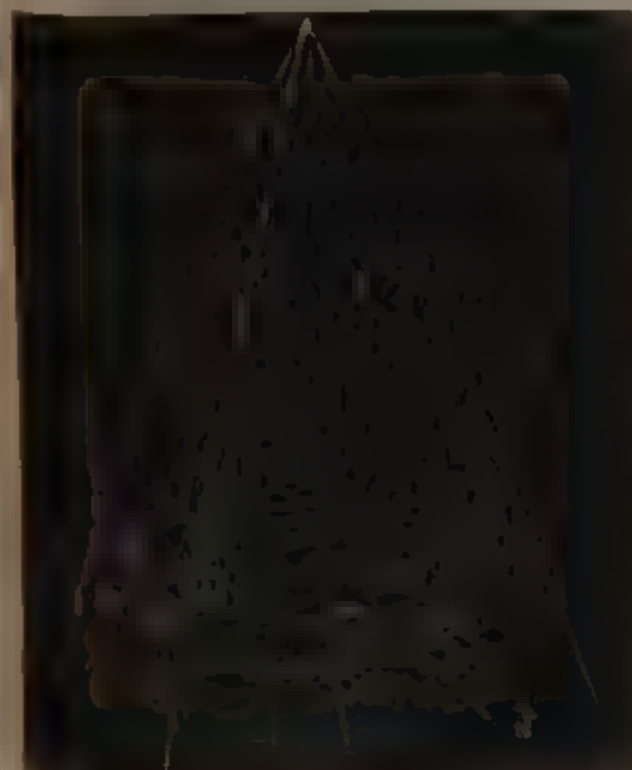


Fig. 6. *Linyphia communis*. b, bowl; d, spinning dish; r, snare of right lines.

the under part of leaves, or suspended between twigs, as in the web of *Linyphia costata*. Second, the web represented at Fig. 6, the snare of *Linyphia communis*. It is composed of a mass of right lines, *r*, to which is suspended a bowl-like sheet, *b*, beneath which again is a dish-shaped sheet, *d*, of more open spinning work with the concavity upward as in the bowl. The snare from which the figure was drawn (Aug. 15, 1877, Delaware Co., Pa.) had a total height of from 12 to 14 inches; the diameter of the bowl was 6 to 7 inches, its depth $1\frac{1}{2}$ to 2 inches. The spider hung,

inverted, to the lower surface of the bowl, and was thus protected from assault by the underlying dish, *d*.

A third variation is that of the beautiful snare of *Linyphia marginata* (*L. marmorata* of Hentz), which is in form precisely that of Fig. 6, except that the bowl becomes a dome; that is, the

sheet, *b*, has the concavity downward instead of upward, and the dish, *d*, undergoes the same change. In other words, the web of *L. marginata* has the exact form of the Basilica spider's web, except that in the latter the dome (*d*, Fig. 1) is constructed of open, regular meshes, formed by the intersection of radiating ribs of silk by notched concentrics. In the former (*L. marginata*), this bowl is woven of irregularly placed threads into a thin sheeted web. The lower curtains, *cc*, and the upper reticular web, *rr*, are substantially the same in both. That is to say, the typical character of the orb-weaver's snare, viz., regular radiating lines regularly crossed by spiral lines, appears in the web of *Ep. Basilica* without any other change from a fixed generic Linyphiid web. Fig. 7 represents the snare of *L. marginata* as drawn from an example suspended within an opening in a pile of pine boards at Bellwood, in the Allegheny Mountains. The snare commonly has the pyramidal form of Fig. 6 when hung among bushes, weeds, and grasses, its most natural site.

FIG. 7



Snare of *Linyphia marginata* as it is seen in situ, situated at Dome
c Lower curtain

We may trace this interesting analogy from another point in the group of orb-weavers, and find yet further coincidences. It will be noticed that the typical orb of the *Orbitelariæ*, as represented at *o*, Fig. 5, is vertical, while the corresponding section of

the web of the Basilica spider Fig. 1. *dd*, may be properly described as horizontal. That is to say, if a horizontal orb attached at the circumference in the usual way, were to be lifted up by a thread fastened in the centre, it would assume the shape of the ~~web~~ in the web of the Basilica spider. In point of fact, this effect might be produced from the characteristic snares of certain species of the orb weavers, which, as has already been stated, are woven in a horizontal plane, at times more or less inclined by the force of circumstances. Our most common examples of these species are the Stilt spider (*Epeira gratulator*), and the Orchard spider (*E. hortorum*). Fig. 8 represents the snare of the latter.

Fig. 8



The diameter of the orb is quite habitually from seven to nine inches. The spider, one of the most beautiful of the order, hangs inverted at the open central space, Fig. 9, *c*, whose diameter is about the length of her body. Next to the open central is a series of concentrics which are most frequently ten in number.

They are closely drawn, the ten covering a space of one-half to one-third of an inch. These concentrics have the same notched arrangement as the spirals in the dome of the Basilica spider. (See

Fig. 9 compared with Fig. 1.) Next follows a free space, *ff*, about one inch in width, beyond which are spirals, in number usually about thirty, which cross the radii at right angles in the usual way. The number of radii generally about corresponds with that of the spirals, and at the circumference they are from one-sixteenth to



Fig. 9. Spiral in Notched
Free space

one thirty-second of an inch apart. Beneath the orb, reaching outward sometimes ten inches, is a mass of reticularian lines, Fig. 8, *rr*, which for the most part extend under but two sides of

the orb. The spinning work of this mass is much more open than the corresponding objects, *c c*, in the Linyphian webs above described, but the resemblance is marked. If one were to fasten the thread to the central point of the orb in the orchard spider's web, Fig. 8, and gradually lift it until the orb should assume the dome shape, he would have a snare very strongly resembling that of the Basilica spider. The difference would be in the absence of the retitelarian web above and around the dome, and the presence of the peculiar arrangement of the spirals just noted.

We have thus traced the analogy between the spinning work of this species of the orb-weavers, and that of the line-weavers, in these several particulars; *first*, in the dome-shaped snare and dwelling place; *second*, in the mass of retitelarian lines placed around and above the dome; *third*, in the sheet-like curtain underneath the dome. Our *E. basilica* is seen to possess all the characteristics of the families of the *Retitelariæ*, viz., right lines and sheet-web in exact detail, and dome-shaped web in outline. It also is seen to possess the chief characteristic of the *Orbitelariæ*, viz., the geometric web, or radiating lines regularly crossed by concentrics; to combine, moreover, in its dome structure the vertical and horizontal forms of the geometrics, and to have the notched arrangement of the spirals peculiar to webs of some species. The Basilica spider may therefore be regarded as well nigh, if not completely, bridging the space between the spinning



ARANEÆ.

ORBITELARIÆ.

EPEIRINÆ.

1. *Epeira basilica*, n. sp. ♀. Fig. 2, p. 126. Length of body .28+ inch.

The cephalothorax is oval, longer than broad; color livid yellow, with irregular black bands around each margin, and a medial band, black, extending to the eye-space; the base is rounded, the grooves and indentation distinct. Beneath the sternum is a long oval, pointed toward the abdomen, wide black bands at the margin, inclosing a scalloped, yellow medial band, in which are two parallel rows of blackish dots, of three each. The head is slightly elevated beyond the thoracic juncture, but gradually depressed toward the eye-space. The eyes are in two semicircular rows, Fig. 3, the inner row concave toward the front, the outer convex. The lateral eyes are in contact, the foremost being much the smaller. The four medial eyes form a quite regular parallelogram, somewhat longest longitudinally; these and the two inner lateral eyes are about equal. The eyes of the hind row are separated from each other by about the same distance. The distance between the anterior middle eyes is slightly less than between the posterior middle. The distance from the margin of the clypeus to the anterior middle eyes is about equal to one-half the distance between the anterior and posterior middle eyes. The falcæ are conical, vertical, slightly inclined inward, of a livid yellow color, touched with black at the tips. The maxillæ are gibbous, hairy at the edges, blackish. The lip is black, subtriangular, almost semicircular, rounded at the base into a concavity in the sternum. The palpi are yellow, with green annuli at the joints, the radial and digital joints well armed with long bristles, shorter, and more numerous at the tips which are armed with a strong pectinated claw. Legs 1, 2, 4, 3, the difference in the length of the 1st, 2d, and 4th pairs being very small; the 2d pair, if anything, a little the longest; the length of these is about $\frac{1}{8}$ of an inch; of the 3d pair about $\frac{5}{8}$ of an inch. The femur has numerous spinous bristles, arranged in spirals on the first two pairs, longest beneath, and numbering six. On the tibia and metatarsus are three spirals of long spines, each spiral having four spines. Short comb-like bristles continue to the claws along the meta-

tarsus and tarsus. The claws are of the typical *Epeira* number and form.

The color of the legs is green, with blackish rings at the joints; there are two blackish longitudinal bands or lines on the thigh, which are somewhat wider and more distinct on the first two pairs of legs. The abdomen is three-sixteenths of an inch in length, subcylindrical, overhanging the cephalothorax slightly, and at the apex, protruding above the spinning mammulæ. It is formed and marked as in the figure. The colors are as follows: above or on the back waving lines, crimson, except toward the apex, where they are blackish, inclose a lobed band, white at the base, yellowish at the middle lobes, and golden at the apex where it terminates in a cruciform figure. On the sides the order of color is, a crimson band; white; light green with dark green edges; yellow. Beneath, the abdomen is blackish with yellow dots and spots.

Habitat: Texas, near Austin.

2. *Epeira globosa*, Keyserling. Fig. 4, p. 127.

Verhandlungen des zoologisch-botanischen Vereins, XV. 1865, p. 830.

Length of body, ♀, one-fourth inch; ♂, three-sixteenths inch; width of abdomen of ♀, one-eighth inch.

The cephalothorax is of a uniform livid yellow color, convex, nearly smooth, cut off squarely at the base, rounded on the sides, highly compressed in front, the medial indentation deep. The

and cut squarely at the tip. These last three parts are of a chocolate-brown color except a broad medial yellowish longitudinal band in the sternum. The legs are in order of length 1, 2, 4, 3, are armed with spines and bristles, and have three claws of the usual epeiroid structure. In color they vary, according to age, from olive green to livid yellow, with anuli, quite black on the tibia and metatarsus. The palpi are colored like the legs, and have a strong pectinated claw. The abdomen is hairy, reticulated, overhangs the cephalothorax. It is of an olive green or livid, and strongly marked on the back with a butterfly-like figure, white, with black edgings; a line of white spots extends along the sides on either side, beneath a black lateral band above the venter. Across the base of the abdomen in front extend two rows of black dots, the lowest the shorter.

The ♂ does not greatly differ from the ♀, but is smaller. The digital joint is a prominent bulb, covered with curved bristles, convex externally, less convex within, and compressed toward the tip. Just within the palm is a straight spine, pointing outward.

This spider makes a composite snare, as described and figured above, Fig. 5, being a vertical orb, with a free radius, and surrounded above with a snare of right lines.

Habitat: Eastern Pennsylvania and New Jersey. Probably the entire Atlantic coast.

NOTE ON THE PROBABLE GEOGRAPHICAL DISTRIBUTION OF A SPIDER
BY THE TRADE WINDS.

By REV. HENRY C. MCCOOK.

While examining and classifying the collection of spiders in the Academy of Natural Sciences of Philadelphia, I discovered a number of specimens of the large laterigrade *Sarotes venatorius*, Linn., from various localities, as represented upon the accompanying tables and chart (Fig. 1). Starting with the specimens in my private collection, the line of distribution was traced from Santa Cruz, Virgin Isles, to Cuba, to Florida, across Central America, Yucatan and Mexico, across the Pacific Ocean by way of Sandwich Islands, Japan, and Loo-Choo Islands, and thence across the continents of Asia and Africa to Liberia. The line thus indicated extends from the extreme eastern limit of North America to the extreme western coast of Africa, thus girdling the globe, with the exception of 54° of longitude. This excepted area expresses substantially the width of the Atlantic Ocean.

It occurred to me when this fact became apparent, that this line of distribution is within the belt of the North Trade Winds; and further, that there might be some connection between the two facts and the fact that the laterigrade spiders, to which group this animal belongs, are among those which are most addicted, in the earlier stages of growth, to the interesting habit of migrating from point to point. This is done by means of fine threads, emit-



Academy and my own collections, whose habitats are personally known, are marked by an asterisk (*). The species is credited to the other localities named on the authorities given therewith.

A comparison of this table with the chart will at once show that the dotted lines in the latter, which indicate the limits of the geographical belt over which (so far as the specimens in hand and described can determine) *Sarotes venatorius* is distributed, correspond, with remarkable general exactitude, with the belt over which the North Trades blow. It is not, therefore, an improbable conjecture that this distribution has been accomplished by means of those winds and the habit of aerial flight above referred to. It is, of course, supposable that commerce, following largely the same belt, may have originated or aided this distribution. But it is hardly necessary to resort to this hypothesis, when there is one quite as probable, and wholly natural, and operative *before* the general diffusion of inter-continental communication by ships. This last-named condition the facts in the history of the spider seem to require.

Some of these facts are, (1) the early discovery of the species as already widely distributed; (2) its presence at so many different insular points nearly or altogether contemporaneous with their first visits by commercial nations; (3) the existence of the species or its close allies among the fauna of the tropical interiors of continents far distant from coast lines; (4) and finally the variations, chiefly in color, which have been observed, and which would seem to require for their development a longer period than that which has transpired since the commencement of commercial communication with the localities in which the variations have been wrought. While one may not conclude with absolute certainty from these facts, they certainly warrant the theory that the Huntsman (*venatorius*) spider has become cosmopolitan by the action of nature independent of the aid of man.

I was so impressed by the above chain of facts, and so confident of the inference therefrom, that I ventured to predict that corresponding results would follow a comparison of specimens collected from all other quarters; that is to say, they would be found to lie within the belt of the North or South Trade Winds. The only specimens at hand were those cited above, and from Zululand and Surinam. But I was enabled to pursue the matter fur-

Fig. 1—Chart of Distribution of *Sarotes venatorius*.



A A, B B, belt of North Trade. C C, D D, belt of South Trade.

ther by reference to the locations of various specimens given in the descriptions of a number of naturalists. I was greatly aided in this by references kindly sent me by Mr. Wm. Holden. Some of the localities thus obtained have been tabulated above, and others were found to correspond with the points represented by specimens examined. So far then the conjecture was verified.

The two lower arrow lines in the chart, *C C* and *D D*, give a general view of the course and limits of the South Trades, which prevail in the Atlantic Ocean between latitude 4° N. and 22° S., and in the Pacific between latitude 4° N. and $23\frac{1}{2}^{\circ}$ S.¹ It is of course understood that these limits are not stationary, but follow the sun, moving northward from January to June, and southward from July to December; an oscillation which is also indicated in the zone of distribution. They are, however, substantially as above given, and may be compared with the following table, which shows the southern geographical distribution of this species according to the authorities cited therein.

Table of Distribution North of the Equator.

Locality.	Latitude.	Longitude (Gr.).	Authority.
1 Palmyra Island,	6° N.	163° W.	*
2 Pelew Islands,	7° – 8° N.	134° E.	L. Koch.
3 Lau-Choo Islands,	25° – 29° N.	128° E.	*
4 Japan,	30° – 40° N.	130° – 140° E.	*
5 Nicobar Islands,	6° – 10° N.	96° – 97° E.	Böck.
6 Tranquebar, India,	12° N.	80° E.	Fabricius.
7 Liberia, Africa,	5° – 0° N.	10° W.	*
8 Senegal, Africa,	17° N.	16° W.	Walckenaer.
9 Martinique, N. America,	15° N.	61° W.	*
10 Santa Cruz,	18° N.	65° W.	*
11 Jamaica,	18° N.	77° W.	Walckenaer.
12 Cuba,	20° – 23° N.	74° – 85° W.	*
13 Florida,	30° N.	81° W.	*
14 Yucatan,	20° N.	82° – 91° W.	*
15 Mexico, Jalapa,	20° N.	97° W.	*
16 California,	?	109° – 117° W.	L. Koch.
17 Oahu, Sand. Islands,	20° N.	155° – 160° W.	*

¹ An error appears in the chart in the location of the southern limit of the South Trades. The arrow line should not run directly westward from Valparaiso, Chili (13), but from a point 10° above it, passing just south of Friendly Isles (19).

Table of Distribution South of the Equator.

Locality.	Latitude.	Longitude (Gr.).	Authority.
1. Viti Levu, Feejee Islands,	16° S.	180° W.	L. Koch.
2. New Caledonia,	20°-22° S.	163°-168° E.	"
3. Sidney, Australia,	33° S.	150° E.	Böck.
4. Australia,	11°-30° S.	103°-115° E.	L. Koch.
5. Singapore,	2° N.	104° E.	Walck.
6. Zanzibar, Africa,	6° S.	40° E.	Gerstaecker.
7. S. E. Equatorial Africa,	10°-20° S. (?)	30°-50° E.	Blackwall.
8. Mauritius,	20° S.	56° E.	Walckenaer.
9. Madagascar,	8°-26° S.	43°-50° E.	Vinson.
10. Zulu-land,	20° S.	28° E.	"
11. Pernambuco,	7° S.	37° W.	"
12. Brazil,		37°-70° W.	Simon, Walck.
13. Rio Janeiro,	23° S.	50° W.	Walck.
14. Surinam,	6° N.	53° W.	"
15. Valparaiso, Chili,	33° S.	70° W.	L. Koch.
16. Tahiti, Huahelme, Soc. Is.	18° S.	150° W.	L. Koch.
17. Rarotonga, Cook's Is.	22° S.	162° W.	"
18. Upolu, Navigator Is.	13½°-14½° S.	168°-173° W.	"
19. Tongatabu, Friendly Is.	20° S.	172°-176° W.	"

This table shows a distribution corresponding with the limits of the South Trades, with, in three cases, viz., Sidney (3), Surinam (14), and Valparaiso (15), a slight oscillation in accord with a fact above stated. Thus was entirely fulfilled the expectation with which I entered upon its preparation. It might with equal confidence be predicted that *Sarotes venatorius* may be found distributed throughout the South Pacific Islands within the same general belt; and that it may be found among the latter

There seems nothing improbable in the theory suggested to explain the series of facts here presented. There are not, indeed, many recorded observations of the distances to which spiders are carried out to sea in their aeronautic flights. But before a strong, steady wind, or in cases of storms, it is possible that the greatest distances which appear in the tables could be overcome. An observation of Mr. Darwin is the only one in point to which I can refer.¹ At the distance of sixty miles from land, while the *Beagle* was sailing before a steady, light breeze, the rigging was covered with vast numbers of small spiders with their webs. The little spider, when first coming in contact with the rigging, was always seated upon a single thread. While watching some that were suspended by this filament, the slightest breath of air was found to bear them out of sight. I have observed similar single-threaded "balloons" sailing at a considerable height above the surface of the earth, and know no reason why, with a favorable breeze, they might not have been carried hundreds of miles. That they were carried at least sixty miles, as Mr. Darwin's testimony shows, and that before a light breeze, gives great probability to such a conjecture. It is to be noted, moreover, that the spiders arrested by the *Beagle's* rigging were evidently moving on when so stopped, and some of them when arrested soon resumed their flight across the main.

The purpose in nature of such a remarkable habit as these well-known facts exhibit is, doubtless, to secure the distribution of species throughout wide regions. The buoyant filament of spider-gossamer serves the tiny arachnid the same good office that is rendered the thistle-seed by the starry rays of down surrounding it.

It may not be without interest, and may, perhaps, have some bearing upon the above theory of distribution, to remark that the genus (or a closely allied genus) to which *Sarotes venatorius* be-

tion of this communication as above, and the preparation of the chart, I received from Mr. Wm. Holden, of Marietta, Ohio, a number of references from Koch's descriptions of Australian spiders, to which I did not have access, which enabled me to verify in this particular also the prediction made. The tables and chart have been corrected in accordance with the facts thus kindly supplied, but the above paragraphs have been permitted to stand as they were originally written and communicated to the Academy.

¹ Voyage of the *Beagle*, vol. iii. p. 187.

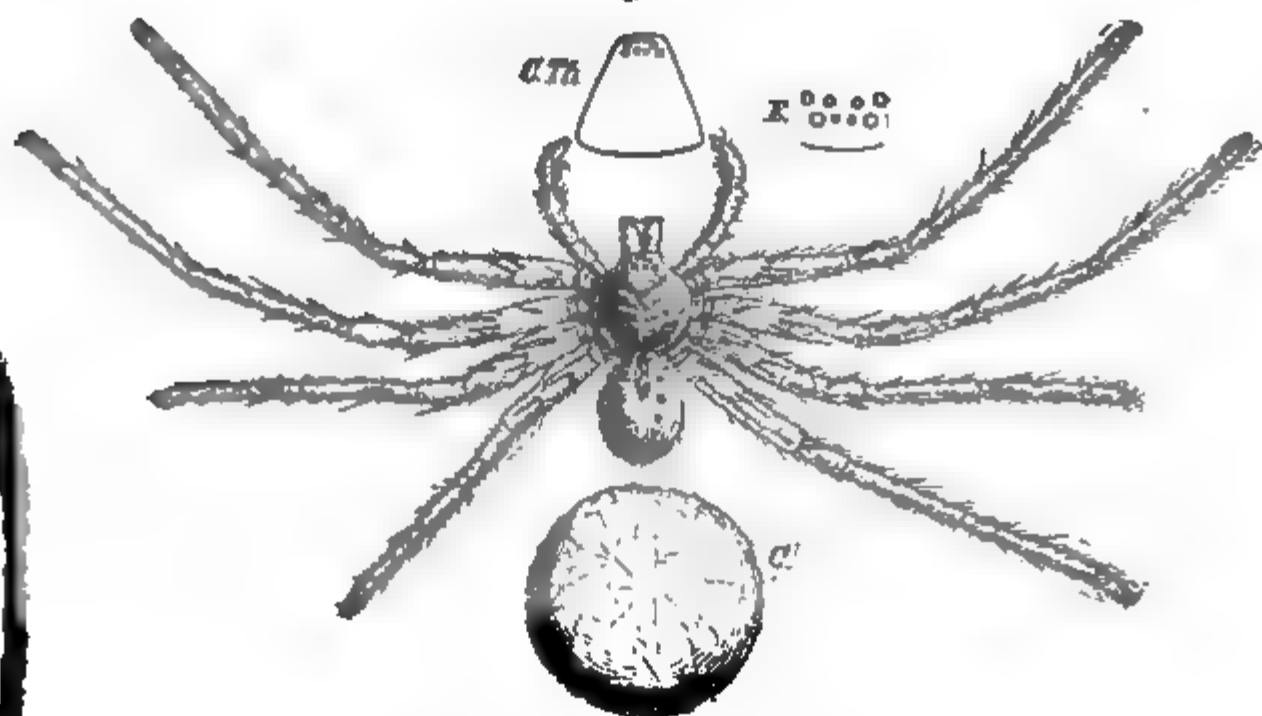
longs is probably one of the oldest known forms of the spider fauna. Thorell¹ places the now existing genus *Heteropoda* (*Oxy-
pete*, Koch, *Oxypete*, Menge), from which *Sarotes* has been di-
vided, among those which are represented in the amber spiders.
This amber is a fossil vegetable resin, which is met with in various
brown-coal strata, and is copiously thrown by the waves on the
southern coasts of the Baltic, especially the coast of Prussia and
the Kurische Haaff. This amber belongs to the tertiary ("oligo-
cene") period, and in it numerous spiders are found, generally
well preserved. How far any supposed contiguity or closer ap-
proach of continents now separated might have facilitated or oc-
casioned the world-round distribution of our Huntsman spider, is
a point upon which geologists may more properly express an
opinion.

The question, what variation of species, if any, occurs in the
course of this distribution, is of great interest. The specimens
examined by me show no variations which may not be accounted
for by differences in age, or which may not come within the range
of those ordinary natural differences which all animals more or
less exhibit. Most of the specimens, however, had been so long
in alcohol as to obliterate any differences in color which might
have existed. The normal color is a uniform tawny yellow, varied
upon the cephalothorax by a circular patch of blackish or black-
ish-brown color covering nearly two-thirds of the space; and

specific characters can be established as upon the more stable differences in the relative size of the eyes and legs.

A female, closely resembling the male which is here figured, was sent to me from Vera Cruz (Virgin Isles) by Mr. F. G. Sherman. It was taken in or near the house by one of the colored servants, who (says Mr. S.) handle the spiders readily and with impunity. The cocoon, Fig. 2, *C*, was inclosed in the box. It is of a pink color; is drawn about natural size, being over three-fourths of an inch in diameter. Cocoons of the same description were sent me by Mr. Jno. F. Folsom from Cuba, together with a large number of young spiderlings. These had evidently escaped from the cocoon, after immersion in the spirits. They are three-thirty seconds of an inch long; whitish color, with reddish-brown annuli or regular markings upon the legs, and two rows of dots of the same color on each side of the medial line of the abdomen.

Fig. 2.



Serv. et serv. et serv. (natural size) C. Cocoon E. Eyes. C Th. Outline of cephalothorax of *S. truncus*.

The male, Fig. 2, was received from Archibald McIntyre, Esq., who brought it from Florida in the winter of 1874-75. It was observed for the space of five or six weeks hanging listlessly to the wall in the angle of the ceiling. It then moulted, moved, and was captured. The length of body is about three-quarters of an inch; the abdomen being somewhat shrivelled, its length is some-

what uncertain. One of the 4th pair of legs is shorter, imperfect, showing that the original leg had been lost in combat or by some accident, and that a new leg had thus far been restored by nature. The fact that both these specimens—the only ones in hand of whose habits I have any account—were found in the house would seem to indicate a fondness for such domicile, that might make more easy the distribution of this species by means of ships. Moreover, Latreille records,¹ as a fact communicated to him, that in certain parts of the tropical regions of the New World, this animal, instead of being looked upon with aversion, as are the most of its order, is regarded with positive pleasure by proprietors of homes, on account of the service rendered in the destruction of cockroaches and other noxious insects. For this purpose the spider is not only preserved, but is introduced within the house. Mr. Holden has information of the same fact in connection with this or an allied species in the Sandwich Islands. It may be said that the general habit of the entire group of laterigrades is, however, quite different from that of house-spiders. They chiefly inhabit trees and shrubbery, upon the leaves or bark of which they lie in wait and seize their prey as from ambush. The spider is probably rare, at least not abundant, in the United States. It has frequently been described in European journals; but, as it has a place among our spider fauna, a description is herewith appended, together with a synonymicon of the most important references.

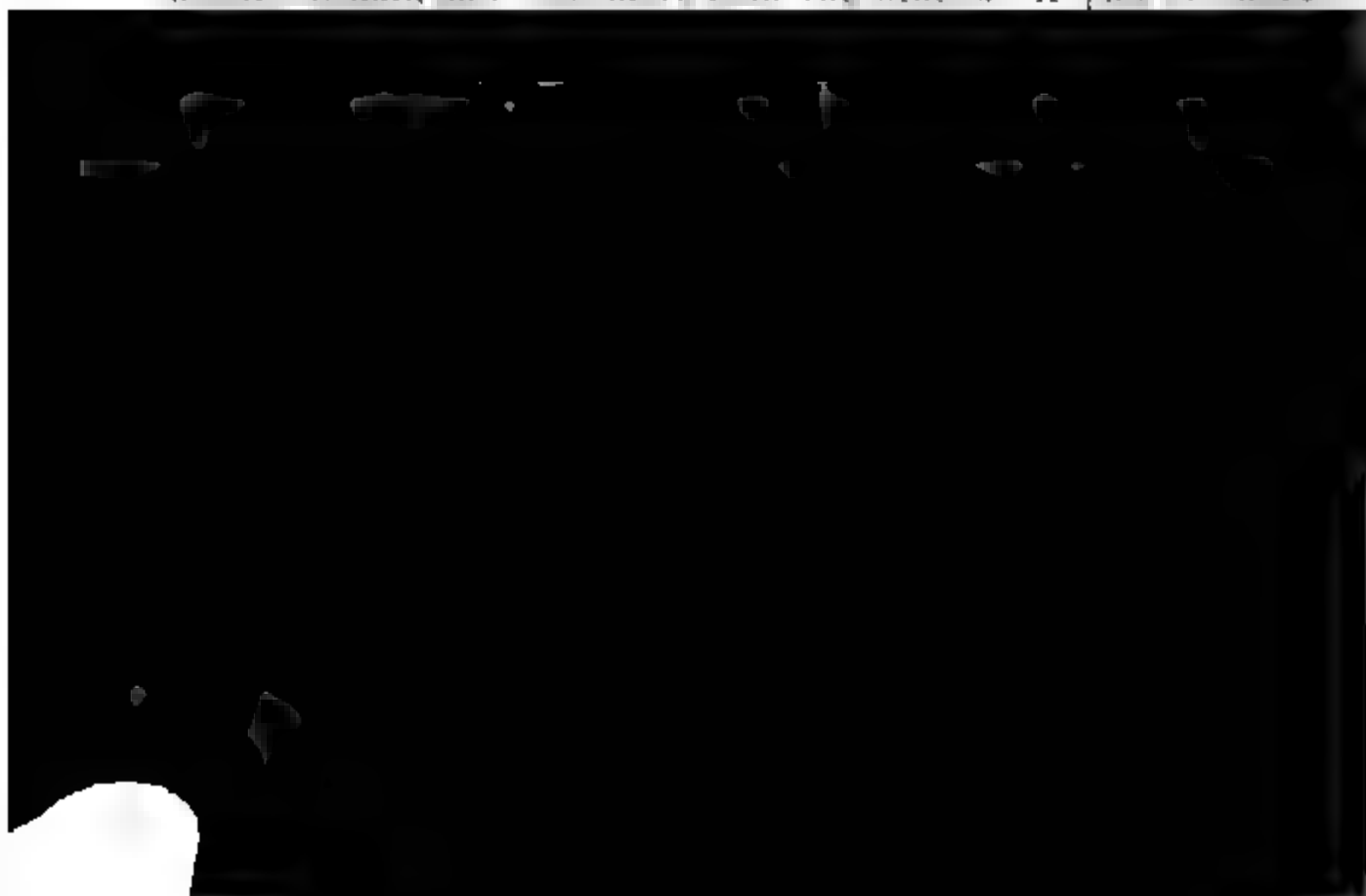
1806. *Thomisus venatorius*, Latr., Gen. Crust. et Ins. I. p. 114.
 1806. *Thomisus leucosius*, Latr., Gen. Crust. et Ins. I. p. 113.
 1810. *Aranea regia*, Epit. Entom. p. 111.
 1829. *Thomisus leucosius*, Latr., Cuvier, Regne Anim. IV. p. 256.
 1833. *Sarotes regius*, Sund., Conspect. Arachn. p. 28.
 1836. *Thomisus leucosius*, Duges, Regne Anim. Arachn. p. 60.
 1837. *Olios leucosius*, Walck., H. N. d. Ins Apt. I. p. 566, No. 5.
 1842. " Lucas, H. N. Cr. Ar. et Myr. p. 395, No. 3.
 1845. *Ocypete draco*, C. Koch, Die Arachn. XII. p. 44, f. 983.
 1850. " C. Koch, Uebersicht, V. p. 37.
 1851. *Olios leucojus (leucosius)*, Böck, Verh. z.-b. Ges. Wien, XI. p. 389.
 1863. " " Vinson, Ar. Reun. Maur. et Mad. p. 98,
 No. 3, pl. ii. f. 3.
 1864. " " Simon, H. N. d. Araign. p. 410.
 1866. " " Blkw., Ann. Mag. Nat. Hist. 3d ser.
 XVIII. p. 457.
 1870. *Heteropoda venatoria*, Thor., On Europ. Spid. p. 178.
 1873. *Olios regius*, Gerst., in C. von der Decken, Reisen in Ost. Afr. III. ii.
 p. 482.
 1875. *Sarotes regius*, Koch, Die Ar. Austr. pp. 660, 675, 854, Tab. 56, f. 1, 2.

Length of body, five-eighths inch. Spread of legs, five inches. Cephalothorax slightly convex, large, broad, broadest through the middle part, rounded on the sides, slightly truncated at the base, very little compressed in front. The caput is but little elevated; is truncated at the face. The color of the spider is a uniform tawny, except upon the cephalothorax, where a broad, brownish, and black band flows down about two-thirds the distance from the medial line to the margin. The margin of the cephalothorax is again of a tawny color, the band running around in front, narrowing toward the face, which it crosses just above the articulation of the falces, the color being whitish on the face. The head and eye-space are touched with black, or are tawny. At the indentation the blackish band divides by a tawny line which follows the cephalic juncture around to the face. The eyes, Fig. 2, *E*, are arranged in two rows of four each, the front row being the shortest. The two central front eyes are the smallest of all, and are placed upon an elevation narrowing towards the front. These are nearer to each other than are the two posterior middle eyes, from which they are separated by a space somewhat larger than that which separates the front eyes and the margin of the face. The lateral front eyes are the largest of all. Viewed from the front they are nearly in a straight line

(subrecta); but viewed from above they are slightly curved backward. The back row of eyes is about equally (perhaps even less) curved backward. They are more nearly equal in size, but the lateral eyes are larger than the middle ones. A whitish line below the eyes joins the face with the falces, which articulate nearly upon a plane with the face. They are conical, covered with bristles, rather blunt at the end, but cut away upward and toward each other. They have about six teeth. Lip is oval, cut squarely at the tip. Maxillæ are gibbous, lean toward the lip slightly, are rounded at the end, scalloped at the middle of the outer edge, tipped with thick tooth-like hairs. Sternum cordate, tawny color, hairy. Palpus of female (Santa Cruz) long; the joints armed with about five strong, short spines each, the terminal joint ending with a thick brush of bristle-like hairs, imbedded within which is a five-toothed claw. The palpus of the male has on the outside of the digital joint a black, double-toothed, or notched, horn-like projection. In the palm of the terminal bulb is a black cushion, from or below the end of which projects a pinkish, spine-like organ. On the end of the radial joint without is a black, corneous projection, curved at the extremity.

Feet, order of length, 2.4.1.3, the difference between 4.1. not very marked.

On the upper part of the thigh (femur) are arranged eight black spines, six in pairs along the upper side; two along the very top, one of these two being in a row with the 2d pair, the other standing alone near the joint of the patella. This last is shorter by about one-half, and bent more than the others. A pair of short



Sarotes truncus, n. sp. ?

In the collection referred to in the above paper was found one specimen which differs so widely from other individuals in the shape of the cephalothorax that it is probably entitled to be classified as a new species. The cephalothorax, Fig. 2, *C.Th.*, is truncated at the base, which is the widest part, being three-eighths of an inch wide, which is also the length of the medial line of the cephalothorax. The sternum is an almost regular decagon. The eyes and other parts correspond generally with those of *S. venatorius* as described. The view of the eyes in the figure is from above.

Female. Japan.

APRIL 9.

Mr. GEORGE W. TRYON, Jr., in the chair.

Twenty-two persons present.

The following papers were presented for publication:—

“Transition forms in Crinoids, and description of five new species,” by Charles Wachsmuth and Frank Springer.

“On a new Species of Sponge,” by Alpheus Hyatt.

Vegetative Repetition of Cerebral Fissures.—Dr. A. J. PARKER remarked that in studying the cerebral fissures, as found in the brains of different animals, we find them divided into several groups. These are called primary, secondary, tertiary, etc., according to their constancy and degree of importance. The primary fissures comprise those fundamental, deep, and important clefts, which appear earliest in the development of the embryo, and are to be found represented in all brains where marked fissuration exists. They correspond in position and bear definite relations with deep and important structures. The secondary fissures come next in importance. They appear in the embryo after the primary, and comprise those fissures which give the general character of fissuration to groups of brains. Tertiary fissures, etc., are the smaller, less important ones which branch off from the primary and secondary, or mark more or less deeply the various separate convolutions formed by the other fissures. These fissures give the special character to each brain, and enable us to point it out as belonging to this or that genus or species of animals. The constancy in appearance and position of these fissures follows the

growth; that is, along these lines of the cerebral cortex, growth takes place less rapidly than in the surrounding portion, and these lines are, therefore, gradually converted into deep grooves or fissures. The third view is a compound of the other two. According to this, the principal fissures are produced by retarded growth, whilst many of the undulations and minor furrows are produced by compression.

Whichever view we adopt, the question still presents itself, are we to regard each fissure as produced by a distinct and separate process of formation, or are some of them only repetitions of fissures previously formed? In studying the cerebral fissures as presented in the brains of different animals, especially amongst the Carnivora and Ungulata, it had appeared to him that many of the fissures should be regarded in the latter light, that is, as vegetative repetitions. Viewed in this way, many difficulties with regard to the identification of homologous fissures in different brains disappear. According to the mechanical theory, a deep and distinct fissure having been formed, there would be a tendency to produce other fissures following the same general direction, having the same general appearance, and depending for their formation on the one originally laid down. According to the view that fissures are the result of retarded cerebral growth, we may expect to find, especially in lower forms of brains in which much fissuration exists, vegetative repetitions of the same lines of retarded growth. In either case, the fissures which appear after the original fissure, and which follow its general contour, should be considered as belonging to one group with that fissure, and to be of secondary importance in relation to it. Hence, in many cases, instead of seeking for fissures separately homologous to each other, we will be obliged to consider certain groups to be homologous to certain other groups, the number of separate fissures of which may be more or less numerous. Owen, in founding his nomenclature of the cerebral fissures in the Carnivora and Ungulata, gave a distinct and separate name to each fissure, and he endeavored to point out the homologue of each of these in different brains. If, however, we are to regard, as he should presently attempt to show, that at least some of these fissures are entirely secondary and to be considered as merely vegetative repetitions, then we must not seek, nor is it possible to find, homologues for each fissure, even in closely related brains.

Dr. Parker then proceeded to point out some of the fissures in the brain of the Carnivora and Ungulata, which appeared to him to be of the above nature.

If we take the brain of a carnivorous animal, as the domestic cat for instance, and examine the upper mesial surface of one of the hemispheres, we will find three fissures lying nearly parallel to each other, one above the other and proceeding postero-anteriorly. The upper two of these extend from the posterior extremity of the

hemisphere, whilst the lower one begins a little anterior to the middle. It is the anterior extremity of this fissure which extends in a transverse direction on to the lateral surface of the hemisphere, and is known under the name of the crucial fissure. The whole fissure is called frontal by Owen. The middle fissure he terms the super-callosal, and the upper, the marginal fissure. This represents the state of things very nearly as found in the brains of all of the Carnivora. In some cases, however, he had found only two fissures instead of three, the frontal being continuous with the super-callosal; there being, however, a decided indication of a tendency towards separation at the anterior portion of this fissure. Thus in two specimens of *Coati nasica*, the frontal fissure was a branch of the super-callosal, a notch, however, indicating where the proper super-callosal would end. In two specimens of the brain of the lion, the frontal fissure was barely separated from the super-callosal, and in examining other brains of Carnivora intermediate stages were met with, from the condition as in *Coati nasica* where the two fissures were continuous to the state as found in the cat and ocelot where they are widely separated. It would appear, therefore, that the frontal fissure is of the nature of a separated anterior extremity of the super-callosal; and as such he had regarded it, considering it as a repetition of that fissure. The marginal fissure lies directly above the super-callosal, is similar in appearance and follows the same direction, but is not as deep or well marked, and appears in the embryo after it. This fissure should also, he thought, be considered in a secondary light to the super-callosal and to be a repetition of it. In some of the carnivora, as in the specimens of the brain of the lion, a fourth fissure makes its appearance in this region; lying between the super-callosal and marginal fissures, and similar in appearance and relations to them. He had, therefore, considered all of these fissures as belonging to one group, of which the super-callosal is

parallel with it which may be considered as repetitions of it. In these brains, however, the marginal fissure, which in the Carnivora lies on the mesial surface, appears on the lateral surface of the brain, together with a number of fissures more or less numerous, similar to it, and which are not represented in the brain of the Carnivora. It is this collection of fissures that gives to this region of the brain the complex character, and extensive fissuration which it presents. The brain of the Peccary, *Dicotyles torquatus*, seems to occupy a position in reference to these fissures, midway between the brain of the Carnivora and the brains of the other Ungulata. In the brain of this animal, we find on the mesial surface a distinct and well marked mesial occipito-frontal fissure, extending from the occipital region forwards and encircling the corpus callosum just as the fissura calloso-marginalis does in man, of which it is the homologue. A short distance posterior to its central point, a small fissure forks off from it, still remaining continuous with it. No other fissures are found on the mesial surface proper, but at the edge of the hemisphere, where the lateral and mesial surfaces join, a distinct and well marked fissure is found which follows the direction of the mesial occipito-frontal fissure and corresponds to the marginal fissure of the Carnivora; which he had regarded as a repetition of the mesial fissure, and designated as *mo f'*. On the lateral surface in this brain there are no other fissures which can be considered as repetitions, but as we advance through a series of ungulate brains, this tendency to repetition in this region becomes exceedingly marked, and so numerous that they cover a considerable portion of the lateral surface of the brain. In *Dicotyles*, as we have seen, there is only a single fissure present, but these gradually increase in number until in some brains as many as five can be distinguished. In the Caribou and Sheep, two may be seen. In the Giraffe, Malay Tapir, and Llama, etc., three may be distinguished, and in the Horse he had counted as many as five. It is to this repetition of the same fissure that the exceedingly convoluted appearance of this portion of the ungulate brain is due, and not to the production of fissures which are to be considered as of the same importance as the other fissures of the hemispheres. Thus, although the brains of the Ungulata are much more convoluted than the brains of any of the Primates, except man and a few of the higher apes, still they must be regarded as of a lower type, since this more highly convoluted aspect is produced, not by a greater number of distinctive fissures, but to a great extent by simple vegetative repetition of fissures, which are found represented in these primate brains by a single furrow. Thus, the five fissures as found in the Horse, taken together are equivalent to the three as found in the Tapir, Giraffe, Llama, etc., to the two in the Sheep and Caribou, to the single fissure as found in *Dicotyles*; and finally they are all to be considered as vegetative repetitions of the mesial occipito-

frontal fissure. In the Primates, this fissure is represented by the fissure calloso-marginalis, and here the same tendency is also shown, as we ascend from the lower groups towards Man, to split up into two or more similar fissures. Among the *Lemuridæ*, as *Propithecus*, *Indris*, *Avalis*, etc.; in the *Platyrrhini*, as *Hapale*, *Chrysotrrix*, *Ateles*, *Cebus*, etc.; and in the *Cynomorpha*, as *Macacus*, *Cynocephalus*, etc.; this fissure is represented by a single continuous furrow. In the *Anthropomorpha*, as the Chimpanzee and Orang, this fissure becomes much broken in its character; and in Man it consists of several distinct parts, which are similar in appearance and relations to each other. He had noticed in some brains as many as five or six of these separate and distinct fissures following each other regularly along the course of the calloso-marginal fissure. They tend in appearance towards the shape of an elongated figure four. He had observed that this repetition is especially regular, and well marked in the brain of the negro. The calloso-marginal fissure is described as terminating posteriorly a short distance behind the central fissure, appearing as a slight notch on the lateral surface of the hemisphere. Directly back of this, a small fissure is present, situated on the præcuneal lobule, which has been regarded as a distinct and unimportant fissure merely marking this lobule. From a study of a number of brains, he had been led to consider this as the posterior portion of the calloso-marginal fissure detached from it, just as the anterior portion splits up into several parts. In the Orang and Chimpanzee this also appears to be detached, but in the lower forms the calloso-marginal fissure extends back without any break in its continuity. In the human embryo the calloso-marginal at the sixth month is represented by a continuous fissure, and it is only in the latter stages of development that it breaks up into separate parts. The fissures of the occipital lobe in those Primates in which it is fissured, appear also to be repe-

fissured. These fissures, when they appear, follow the direction of the primary occipital arch, so that a secondary arch appears within the first. This arch, in the same manner as the primary, extends around the upper and lower branches of the posterior extremity of the calcarine fissure. It might be well seen in many of the photographs to which he directed attention, especially in *Macacus nemestrinus* and in *Cynocephalus pora*. Sometimes this secondary arch is interrupted at one or two places by small convolutions, just as the primary arch is by the various *plis de passage*, but the separate portions still preserve the same relations as before. In the higher Apes these arches become more undulated. This is also the case in *Ateles*. In Man they become very much contorted and broken up, and it becomes difficult to recognize the relations between these detached portions and the parts of the primary arch which also become much separated. In the negro, these fissures remain more nearly in the state in which they are found in the higher Simians, and the correspondence between the two arches can be more clearly distinguished. The fissures of the occipital lobe should not, it appeared to him, be considered as of the same significance as the fissures of the other lobes, or as the fissures of the primary arch, but of secondary importance, and he would regard them as repetitions of the two branches of this arch.

In the temporal lobe Ecker has described a fourth temporal fissure in addition to the three usually recognized. This fissure is, however, as he admits, but slightly developed and often absent. He would regard this fissure in the same light as the fissure of the occipital lobe, viz., as a repetition of one of the temporal fissures. These constitute the most important fissures which he had been led to consider as of secondary significance, since they merely follow lines of development already laid down by a preceding furrow, and do not partake of the nature of independent fissures to the same extent as many others, although they may appear by their length and depth to be of equal morphological significance.

The following papers were ordered to be printed:—

STIBIANITE, A NEW MINERAL.

BY E. GOLDSMITH.

In the Academy's collection I noticed a mineral without a name, but having on its label the words "Victoria, Australia." On inquiry, I received the information from the Curator in charge that said specimen had been presented by the Australian Centennial Commission.

The mineral is massive, having the general aspect of a piece of rough feldspar. It is somewhat porous, and occasionally a shining face of a crystal is observed in the mass. The color is reddish-yellow, but not very uniform. In powder, it is pale yellow; its lustre is dull.


Hardness = 5.

Specific gravity = 3.6686.

Blowpipe reactions: On coal, with carb. of soda, it affords antimony, a white incrustation, and on the removal of the flame, the peculiar ascending cloud.

Phosphorsalt dissolves it without any coloration in the oxidizing and reducing flame.

Heated in a tube closed at one end it affords some water. Hydrochloric acid, aqua regia, caustic potassa, and sulphide of ammonium dissolve the antimony compound, but not the gangue



It is evident from these ascertained values that the purity of the mineral is not more than 85.67 per cent., and on recomputing this value to hundred, will give for

$\text{SbO}^5 = 94.79$ per cent. contains $\text{O} = 23.40$.

$\text{HO} = 5.21$ " " " $\text{O} = 4.62$.

The oxygen ratios are: $4.62 : 23.40 = 1 : 5.06$, from which the formula SbO^5HO is derived.

It is generally believed, and probably with good reason, that those oxides of antimony were derived from stibnite, which may also be the case in this instance, as a small patch of stibnite was noticed on the specimen examined.

STAFFELLITE, FROM PIKE'S PEAK, COL.

BY E. GOLDSMITH.

On a specimen of the well-known Amazon stone from Pike's Peak, an incrustation from 4 to 6 millimetres thick was shown for inspection, by Mr. Foot, to the members of the Mineralogical Section. It was given to me for determination, and the results are as follows:

On the upper surface it appears rather flatly mammillary massive, chalcedony or agate-like. If broken with the hammer, the fresh fracture has a silky lustre, due to a microcrystalline structure, which is clearly seen if a thin splinter of it is placed beneath the microscope, having mounted an objective of $1\frac{3}{4}$ inches. The fracture, which is somewhat splintery, but smooth, has a pale gray color; on the upper surface, where the mineral had been exposed, the color appears leek-green, and is rough to the touch.

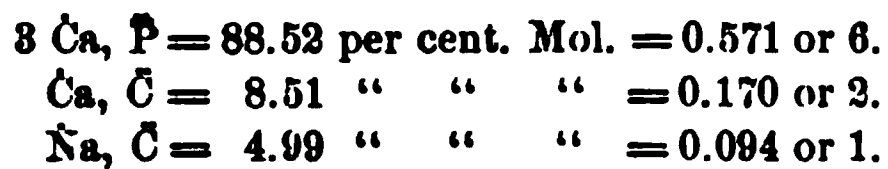
Hardness = 3.5

Specific gravity = 2.959.

Blowpipe reactions: in the forceps, it swells up at first, then decrepitates; the color of the flame is orange-yellow.

Hydrochloric acid dissolves it with slight effervescence of carbonic acid gas to a perfectly clear solution. In the solution was ferric lime and phosphoric acid, and also some soda.

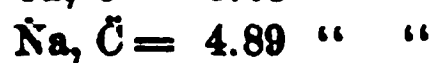
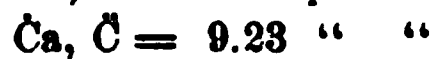
Putting the analytical results together, it reads:



From the ratios, the following formula may be deducted:



This requires 3 Ca, P = 85.87 per cent.



APRIL 16.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-one persons present.

The death of Michel Charles Durieu de Maisonneuve, a Correspondent, was announced.

On the Relation of Amœba quadrilineata and Amœba verrucosa.
—Prof. LEIDY stated that the small but characteristic amœboid form originally described by Mr. Carter (An. Mag. Nat. Hist., 1856, 243) as *Amœba quadrilineata*, from specimens found in Bombay, he had repeatedly observed from many positions in our vicinity. In association with it, he had noticed the singularly sluggish *Amœba verrucosa*, and also many intermediate forms, which led him to the belief that the former was the young of the latter. Subsequently, in reviewing the literature of the matter, he had been gratified to learn that Mr. Carter had arrived at the same result from a different point of view. In investigating the history of *Amœba verrucosa*, he found that its germs yielded young of the character he had previously described as *Amœba quadrilineata* (An. Mag. Nat. Hist., 1857, 37).

The forms described by Perty as *Amœba natans* (Kennt. kleinst. Lebensformen, 1852, 188), by Greeff as *Amœba terricola* (Arch. Mik. Anat., 1866, 299), and by Fromentel as *Thecamœba quadripartita* (Etudes Microzoaires, 346), he suspected to be the same

that it was made by an Indian. Mr. J. W. Foster, in his work on the prehistoric races of the United States, writes that "a wide gap exists in connecting the history of the mound-builders with the present race of Indians." There is a large Indian mound among the mountains in Macon County, North Carolina; and the Cherokee Indians, now living in that vicinity, say that they have no tradition in reference to its construction. Perhaps this copper plate might be looked upon as a connecting link between the mound-builders and the early white settlers in this country, as it was found in conjunction with the skeletons and the stone tools.

Note on Corundum.—Mr. WILLCOX said that the corundum crystals presented by him were found at a locality in Laurens County, South Carolina, that had never been described. He lately visited the place. The corundum is found in a matrix of mica slate, which is considered a new rock for bearing corundum. Commencing at a point three-quarters of a mile east of Laurens Court House, the corundum is found at several places in a district about three miles long and one-half mile wide, in a direction nearly north-east. As is the case all through the Southern States, the rocks in Laurens County are so deeply covered with soil that it is difficult to trace them.

APRIL 30.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-eight members present.

A paper entitled "Elements of the Sidereal System," by Jacob Ennis, was presented for publication.

The Bridging Convolutions in the Primates.—Dr. A. J. PARKER remarked that the *plis de passage* of Gratiolet, the annectant, bridging or transition convolutions of the English anatomists, are small and in many cases concealed convolutions passing from the occipital to the temporal and parietal lobes. Gratiolet attached great importance to these *plis de passage* as points of diagnosis in different brains. He distinguished altogether six of these transition convolutions, four external and two internal. The two internal connect, according to him, that portion of the occipital lobe known as the cuneus, with the mesial portion of the brain directly in front of the parieto-occipital fissure; the so-called lobulus præcuneus of most authors. He called these, respectively, the superior and inferior internal *pli de passage*. The four external *plis de passage* pass from the lateral portion of the occipital lobe to join the convolutions of the parietal and temporal lobes. He named these the first or superior external *pli de pas-*

sage, deuxième, troisième et quatrième pli de passage externe. The inferior internal *pli de passage* passes from the apex of the cuneus forward, and joins the convolution running forward into the frontal lobe. Attention was called to this convolution in a previous communication on the convolutions of the negro brain; but it might be well to refer to it again in this connection. It is this convolution which in the Simians separates the mesial portion of the parieto-occipital from the calcarine fissure. The presence of this convolution was considered as a characteristic of the Simian brain, but Huxley pointed out its absence in the brain of *Ateles paniscus*. Bischoff states, however, that it is present in *Ateles*, only pushed down and concealed in the depths of the parieto-occipital fissure. In the brain of *Ateles ater* Dr. Parker had found this convolution as well developed as in any of the Simian brains. Formerly it was considered that this convolution was absent in the brain of man; but Bischoff asserts that it is always present, sunk in the depths of the parieto-occipital fissure, and Ecker describes it under the name of the gyrus cunei. He had always been able to distinguish it in the human brain; and especially well-developed, as previously pointed out, in the brain of the negro:

The superior internal *pli de passage* lies just above the inferior internal, and connects also the occipital lobe with the lobulus præcuneus. Bischoff has asserted (*Die Grosshirnwindungen des Menschen*, etc., Abhand. der k. bair. Akademie der Wissenschaften, 1868) that the superior external and the superior internal *plis de passage* are identical. Ecker, opposing Bischoff's interpretation, remarks (note p. 75, *Cerebral Convolutions of Man*) as follows: "Bischoff is of the opinion that this convolution (he is speaking

some Simian brains two convolutions are present as described by Ecker, whilst in other brains only one can be distinguished. Thus, in one specimen of the brain of *Macacus nemestrinus*, but a single convolution was present, passing from the lower part of the lobulus præcuneus backwards to join the occipital lobe. This convolution was in shape like the letter S, the anterior arch being directed downwards and inwards, the posterior arch upwards and outwards. The anterior portion of this convolution evidently corresponds to the superior internal *pli de passage*; whilst the posterior arch corresponds to the convolution which Ecker terms the gyrus occipitalis primus, and which Gratiolet and other writers have also separately designated under the name of the superior external *pli de passage*, the superior annectant, bridging, connecting convolution of the English anatomists, Huxley, Turner, Rolleston, and Marshall. He had found the same condition of things in several other brains, specimens of *Macacus cynomolgus*, *Cercopithecus callitrichus*, and in *Cebus apella*. In most brains, however, two convolutions are to be found, an anterior, inwardly arched, and a posterior outwardly arched, corresponding, as had been already stated, with the anterior and posterior portions of what is in some brains a distinct, single, and separate convolution.

With regard to the development and relations of the superior external *pli de passage* considerable confusion exists. This is the convolution, which, lying concealed in most of the Simians under that portion of the occipital lobe known as the operculum, develops in the higher Apes, in Man, and Ateles upwards and divides the fissura perpendicularis into two parts. Until recently only one of these divisions, the parieto-occipital fissure, has been recognized. Thus Marshall, following Gratiolet, in describing the brain of a Bushwoman calls the lateral portion of the parieto-occipital fissure the external perpendicular fissure, thus identifying this with the external perpendicular of the Simian brain. This identification is incorrect, or at least this lateral portion of the parieto-occipital can be considered as corresponding to only a small portion of the external perpendicular fissure. The fissure which represents the external perpendicular is pushed backwards by the development of this convolution, and is found situated apparently on the occipital lobe and continuous with the interparietal fissure. Pansch appears to be the first who gave a correct description and comparison of this portion of the human brain, and he has since been followed by Ecker. Bischoff identifies the internal perpendicular correctly, but he introduces fresh confusion. In the fœtus he recognizes the presence of the external perpendicular fissure, but states that it disappears in the eighth month. This, however, is by no means the case. In five fœtal brains, at the end of the eighth, Dr. Parker had found this fissure distinct and well-developed, and in all adult brains which he had studied he had found it well marked. In the brain of the fœtus, at the end of the

eighth month, this convolution presented almost the same appearance as in the brain of the Orang, according to the figure given by Bischoff. This convolution, the superior external *pli de passage*, varies as to its extent of development in different individuals. In the brain of the negro he had found it much simpler than in the white. Pansch and Ecker are the only writers who recognize in the human brain the fissure corresponding to the external perpendicular of the Simian. Pansch calls it *fissura occipitalis externa*, and Ecker *fissura occipitalis transversus*. The remaining bridging convolutions present nothing of importance. The second lies generally concealed under the operculum. The third passes forward from the apex of the occipital lobe into the second temporal convolution. The fourth lies below this, and passes into the third temporal convolution.

In identifying and limiting these convolutions in the human brain, much confusion has arisen, and he agreed entirely with Ecker, that, although they may have some significance in the brain of the Apes, they have no special significance in the brain of Man, and should not, therefore, receive separate and distinct names. In the human brain they appear merely as the posterior portions of convolutions which extend into the temporal and parietal lobes and connect these with the occipital lobe.

Dr. Jos. W. Anderson, Walter Wood, and W. W. Frazier were elected members.

The following paper was ordered to be printed:—



ON A NEW SPECIES OF SPONGE.

BY ALPHEUS HYATT.

Aplysina pedicellata, Hyatt. (Plate 1.)

This species is founded upon three specimens, two in the collection of the Academy, and one in the collection of the Boston Society of Natural History. Locality is unknown, but probably East Indies.

The forms are all fistular, and from a foot to sixteen inches long, though not more than one and one-eighth inch in diameter. The basal portion is almost solid, and is composed of huge vertical fibres connected by very short horizontal branches, the mesh being very small.

The walls of the tubes are built up out of a thin network of fibres of two kinds. The inner part is a sheet of fibre, which surrounds the tube itself; the outer part is composed of palmate extensions of the inner sheet which anastomose with each other in every direction. In this way they give a cellular, or open frill-like aspect to the walls, since the cells or frills open more widely, or flare outwardly.¹ The mesh in most parts has a quadragonal form, but not infrequently has also the usual pentagonal or hexagonal outline common in most species of *Aplysina*. The fibres are hollow, but this is much larger in the vertical or primary fibres than in the secondary or horizontal fibres. The hollows of the primary fibres are universally filled with debris, but the cavities in the secondary fibres are entirely free from foreign matter.

Another very curious peculiarity is observable in the structure of the fibres. The central core of debris in the primary fibres is surrounded by a cement, apparently of keratode. This may be seen where the secondary fibres branch off from the primary as a continuous layer running across the open face of the secondary fibre.

The size of the cavity in the primary appears to be dependent upon the quantity of the debris in the primary fibres, since in one preparation the cavity of the primary fibres became as small as in

¹ This characteristic is not shown in the figures, which give the walls a solid aspect they do not naturally possess.

the secondary fibres whenever the core of debris failed in continuity.

The diameter of this hollow varies normally from one-half to one-eighth of the whole diameter.

These facts lead to the conclusion that, if this species lived where the water contained no sediment, we should find the fibres with an exceedingly small central cavity. The concentric coats of keratode comprising the fibre are of two kinds as is usual, those which are primarily formed by the derm and those subsequently deposited by the meso-derm, the former being lighter colored, and occupying the interior, and the latter, in the specimens examined, very dark colored and with an exceedingly fibrous aspect.

This thickening of the walls of the fibre by meso-dermic deposits, and the small size of the central cavity, are similar to the characteristics of *Verongia*, to which also the form of the fibre, rounded rather than flattened, approximates.

This species, therefore, presents a mingling of some of the characteristics of *Verongia* and *Aplysina*, and also possesses a curious resemblance to the true Spongiæ in the habit of taking debris into the core of the fibre.

This mingling of characteristics led me at first to the supposition that it was a new genus.

Upon reflection, however, I do not think that these characteristics justify its separation from the genus *Aplysina*.

The peculiar arrangement of the fibres in sheets, and their resemblance in structure, far outweigh all other characteristics, and give a peculiar aspect to the surface which I believe is confined to

MAY 7.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-six persons present.

A paper entitled "Descriptions of New Species of American Bees," by E. T. Cresson, was presented for publication.

The death of Robert Frazer, a member, was announced.

On Lepidurus Couesii, Pack.—Dr. A. S. PACKARD placed on record the occurrence of *Lepidurus Couesii* in northern Utah. The species had not before been found south of northern Montana, near the Milk River. The determination was based upon a specimen of a female with eggs, sent to him by the Academy for examination.

The President read the following:—

NOTICE OF THE LATE DR. PICKERING.**BY W. S. W. RUSCHENBERGER, M.D.**

It is a custom of this Society to announce the death of every member or correspondent when it occurs, without accompanying the announcement with a notice of his career. From this custom may be excepted those members who have been conspicuous by their success in the cultivation of natural science, or who have won the general approbation of the Academy by generous contribution towards the advancement of science, or who have largely aided the progress of the Society by their labors.

For such reasons it seems appropriate that the archives of the Society should contain a record to show why his contemporary and fellow-members entertained sentiments of sincere respect and cordial esteem for the late Dr. Charles Pickering.

The records show that Charles Pickering, M.D., of Salem, Mass., was elected a correspondent of this Society Nov. 28, 1826. He had then just entered the twenty-second year of his age. Early in the following year (1827), he became a resident of Philadelphia, and, therefore, a member. From that date until 1838 he was rarely absent from any meeting of the Academy.

At that time the details of the affairs of the Society were conducted chiefly by standing committees. Dr. Pickering served on the Zoological Committee from December 25, 1827, until January, 1838, ten years; on the Botanical Committee from Dec. 28, 1828

re previously in the collection, many of them Mr. Nuttall's, he intercalated in the Schweinitz herbarium, attaching an appropriate label to each. On the 24th of March, 1835, on motion of Prof. H. D. Rogers it was unanimously resolved, "That the thanks of the Society be awarded to Dr. Charles Pickering for the highly successful manner in which he has executed the very arduous task of collating and arranging the extensive herbarium of the Academy."

The work done by Dr. Pickering has contributed much to facilitate the labors of his successors in the botanical department of the Academy.

On the 26th of Jan. 1836, on motion of Dr. Samuel George Morton it was unanimously resolved, "That the grateful thanks of the Institution be tendered to Dr. Pickering for his voluntary journey to New Harmony, the faithful execution of the trust reposed in him of selecting from the library of Mr. Maclure such works as were designed for the Academy, and for the prompt and successful arrangements made by him for the transportation of said books to this city."

The mission just referred to occupied Dr. Pickering about three months, and brought to the Academy's library an addition of about 2300 volumes of valuable scientific works.

The services of Dr. Pickering to the Academy were important in every sense, and are worthy of grateful remembrance.

While laboring for the Academy, he qualified himself perfectly to discharge efficiently those duties which devolved upon him in 1838, when he became a member of the United States Exploring Expedition. The means and facilities requisite for the instruction and training of students of natural science were at that period nowhere in the country more ample than in the Academy; and it is believed that at this time they are not better in any other institution in the United States.

On the 19th of October, 1827, Dr. Pickering read, at a meeting of the American Philosophical Society, a paper "On the Geographical Distribution of Plants," which was published in the third volume of the Transactions in 1830. He was elected a member of the American Philosophical Society Jan. 15, 1828, and resigned in Nov. 1837.

He was elected Recording Secretary of the Pennsylvania Hor-

ticultural Society Feb. 1830, and served till Sept. 1837, when he resigned.

In conjunction with James H. Dana, Dr. Pickering read, Feb. 20, 1838, before the Yale Natural History Society, of which he was a member, a "Description of a Crustaceous Animal belonging to the genus *Caligus*, *C. Americanus*," which occupies forty pages of vol. xxxviii. of Silliman's Journal.

Dr. Pickering was appointed a member of the scientific corps attached to the United States Exploring Expedition, under command of Lieutenant Charles Wilkes. He was placed on board of the flag-ship *Vincennes*. The expedition sailed from Hampton Roads August 19, 1838, and arrived off Sandy Hook, N. Y., June 10, 1842, after an absence of nearly four years. He is recorded among those present at the stated meeting of the Academy, July 5th, and frequently afterwards until he again went abroad. The first record of his presence after his return is May 20, 1845, and from that date he occasionally attended meetings every year. He was last present November 7, 1876.

October 11, 1843, Dr. Pickering left Boston and visited Egypt, Arabia, India, and the eastern part of Africa, for the sake of extending and verifying observations made while attached to the United States Exploring Expedition. Upon his return he settled in Boston, and prepared his "Races of Man and their Geographical Distribution," quarto, pp. 447, published by Charles C. Little and James Brown, Boston, 1848, being vol. ix. of the Exploring Expedition.

In 1850 he contributed a paper, "Enumeration of the Races of

1867, which is published in vol. xvi. of the Smithsonian Contributions to Knowledge.

The "Geographical Distribution of Animals and Plants. Part II. Plants in their Wild State," quarto, was published by the Naturalists' Agency, Salem, 1876. It is preceded by a note, "The following 524 pages comprise about one-half of a prepared volume, the printing of which was suspended in 1860.—Charles Pickering."

The great work of Dr. Pickering's life, The Chronological History of Plants, to which he had devoted sixteen years of laborious research, was only recently completed, and is now passing through the press.

This imperfect summary of work completed is sufficient evidence of his unremitting industry, and suggests that he fully utilized his opportunities to qualify himself for research during the ten years he zealously wrought in the offices and on the committees of the Academy. He was certainly a distinguished alumnus of the Institution.

Dr. Pickering was characterized by imperturbable firmness of purpose, and by his loyalty to truth, and integrity in every sense. He was extremely modest, averse to parade, and remarkably free from pretension of every kind. His acquirements were extensive, varied, and minutely accurate. His friends loved him for his unaggressive, always tranquil temper, and his obliging disposition.

To this imperfect outline of Dr. Pickering's scientific career, though a thing apart, may be added a few words on his heredity.

Colonel Timothy Pickering, his grandfather, was native of Salem, Mass., but his active participation in the Revolution brought him to Philadelphia. He served in the army, took part in the battles of Brandywine and Germantown, and was present at the surrender of Yorktown. He was appointed Postmaster-General, August, 1792; Secretary of War, Jan. 1795; and Secretary of State, Dec. 1795, from which office he was removed May 12, 1800, by President John Adams. His son, Timothy Pickering, Jr., the father of Dr. Pickering, was born in this city, Oct. 1, 1779. He graduated at Harvard College; was appointed a midshipman in the navy Jan. 17, 1799, served creditably one cruise under command of the famous Stephen Decatur, and resigned May 2, 1801.

His father, Colonel Pickering, had acquired extensive tracts of "wild lands" in western Pennsylvania. Finding himself in re-

stricted circumstances when removed from office by President John Adams, he determined to transfer his family to those lands with a view to their settlement. Timothy Pickering, Jr., joined his father, and settled at Starucca, now in Susquehanna County, Pa. There he married Lurena Cole, Dec. 29, 1804, and there Dr. Charles Pickering was born Nov. 10, 1805. His father died May 14, 1807, in the twenty-eighth year of his age. A few years prior to this date Colonel Pickering had changed his place of residence to a farm at Wenham, near Salem, and thither he took the widow and her son to remain members of his own household. There Dr. Pickering was raised and educated under the immediate direction of his mother, and the supervision of his distinguished grandfather. He was a member of the class of 1823 at Harvard, and graduated from the medical department of the same school in 1826.

Dr. Pickering married Sarah S., daughter of the late Daniel Hammond, Esq., in 1851. He died in Boston, March 17, 1878, leaving a widow but no child. His memory will be affectionately cherished by those who knew him, and his works will secure him respect from all who may follow the same paths of research.

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MAY 14.

Mr. THOS. MEEHAN, Vice-President, in the chair.

Thirty-one persons present.

The death of Prof. Jos. Henry, a correspondent, was announced.

On Parasitic Worms in the Shad.—Prof. LEIDY stated that during the last month he had received letters and specimens, from New York, Trenton, Norfolk, and elsewhere, with information that the shad, this season, was much infested with worms. Two of the writers, physicians, had expressed apprehension in regard to the parasites, and supposed that they had traced several cases of illness to the use of shad which they suspected had been infested with the worms.

The worm has long been known in Europe as a parasite of the herring, mackerel, cod, salmon, and other food fishes. It is the *Filaria capsularia* of Rudolphi, or the *Agamonema capsularia* of Diesing. Prof. L. had described it in the Proceedings of this Academy in 1856, from the shad and herring, and had repeatedly observed it in the same fishes every year since. It usually infests the internal organs, and is often observed encapsulated in a close coil, upon the roes, the intestines, and the liver. It is from half an inch to an inch or more long. Most individuals have a few of the parasites, and sometimes they are exceedingly numerous. They appear not to affect the health of the fishes unless they are very numerous, when they impoverish their hosts. Prof. L. believed that they did not affect the wholesomeness of the fish as food, and perhaps when cooked with the fish were equally good and nutritious. Like others, he felt an antipathy to the worms, and he was in the habit of scraping them off from the roes of smoked herring before eating these. He took the opportunity of adding, what was already well known to naturalists, that most animals are infested with parasites, which were transmitted by feeding on one another. The remedy against transmission was heat. He who uses only well-cooked meats need have no apprehension of worms from such food.

Species of Euglypha, Trinema, Pamphagus, and Cyphoderia, with Synonyma and Descriptions of New Forms.—Prof. JOSEPH LEIDY placed on record the following synonyms and descriptions of new species of Rhizopods:—

1. EUGLYPHA ALVEOLATA, Dujardin, Carter, Wallich, Hertwig and Lesser, Leidy, Schulze.

Euglypha tuberculata, Dujardin.

Difflugia areolata, *D. acanthophora*, *D. lævigata*, *D. striolata*,

D. Floridae, *D. pilosa*, *D. moluccensis*, *D. Amphora*, *D. rectangularis*, *D. Roberti* Müller, *D. seriata*, *D. striata*, *D. Shannoniana*, *D. subacuta*, Ehr.

Euglypha laevis, *E. setigera*, Perty.

Euglypha ampullacea, Hertwig and Lesser.

2. *EUGLYPHA CILIATA*.

Diffugia ciliata, *D. pilosa*, *Setigerella ciliata*, *S. pilosa*, Ehr.

Euglypha compressa, Carter, Leidy, Schulze.

3. *EUGLYPHA SEMINULUM*.

Diffugia Seminulum, *D. Semen*, *Arsulina Seminulum*, Ehr.

Euglypha brunnea, Leidy. *Euglypha tinctoria*, Archer.

4. *EUGLYPHA GLOBOSA*, Carter, Leidy, Schulze.

5. *EUGLYPHA SPINOSA*, Carter, Leidy.

6. *EUGLYPHA STRIGOSA*.

Diffugia strigosa, Ehrenberg.

Frequent in sphagnous swamps of New Jersey.

7. *EUGLYPHA CRISTATA*, Leidy.

8. *EUGLYPHA MUCRONATA*.

Narrow, bottle-shaped, with the fundus terminating in a long spine. Plates oval, overlapping at the borders; the plates of the mouth from 4 to 6, angular and dentate at the free extremity. Length $\frac{1}{8}$ th mm., breadth $\frac{1}{16}$ th mm., mucro to $\frac{1}{30}$ th mm. long. Sphagnous swamps of New Jersey.

9. *EUGLYPHA BRACHIATA*.

Nearly like the former, but without the mucronate fundus, and with 2, 4, or 6 equidistant, long spines diverging a short distance above the mouth. Size about the same as the former, and found in same localities. Both forms are frequent.

12. CYPHODERIA AMPULLA.

Diffugia Ampulla (Werneck), Ehrenberg, 1840.

Diffugia Lagena, *D. Seelandica*, *D. adunca*, *D. alabamensis*, *D. uncinata*, Ehr.

Cyphoderia margaritacea, Schlumberger, 1845, Fresenius, Carter, Hertwig and Lesser, Leidy, Schulze.

Euglypha curvata, Perty.

Lagynis baltica, Schultze.

Euglypha margaritacea, *Diffugia margaritacea*, *Euglypha baltica*, Wallich.

The following papers were ordered to be printed:—

ELEMENTS OF SIDEREAL SYSTEM.

BY JACOB ENNIS.

Hitherto the work of Astronomy has been mainly on our solar system. Beyond this the labor of astronomers has been given to individual stars; but not to these stars as a body forming our sidereal system. The time has now come when the sidereal system as a unit must be made in all its vastness a distinct object of investigation. I have demonstrated that our sun acts powerfully through gravity on the so-called fixed stars, and must receive powerful action in return. This mutual interaction between all the stars would bring them with great violence to this common centre of gravity, and therefore they must revolve with high velocities around that centre to gain a corresponding centrifugal force. Now first we learn the uses of such high velocities as those of 61 Cygni and of Arcturus, the one nearly 2000 and the other nearly 3000 miles per minute. In my Memoir on "Our Sidereal System," published in these Proceedings for 1876, I demonstrated that the centre of gravity of our sidereal system, around which all the stars revolve, must lie in the plane of the median line of the galaxy, that its direction is not far from the south galactic pole, and that its distance is not far from that of the stars of the fourth magnitude. Therefore the vast multitude of the stars visible to the naked eye, say five-sixths of them all, must lie on the same side of the centre of gravity with our sun.

doing I will merely state what have been my own studies on this subject a few years past.

First. After learning the proper motion of a star, the first thing to be done is to lay down the line of its nodes on the plane of the galaxy. This is in many cases a most difficult task. But the easier ones are to be determined first; and these are situated in the close neighborhood of both galactic poles. After the proper motions within 30 degrees of both poles have been finished, as nearly as possible for the present, then the other proper motions more distant from these poles will be more advantageously studied.

Second. The galaxy must be divided into 360 degrees; because the galactic plane must be the basis of sidereal astronomy; and to this all sidereal motions must be referred. I propose that the initial point for numbering the degrees on the galactic circle be the point where the median line of the galaxy intersects the ecliptic, near the convergence of the three bright constellations, Orion, Gemini, and Taurus. From these the numbers should run south-eastwardly until the galactic circle be completed.

Third. The median line of the galaxy should be precisely determined. This is necessary before we can tell where it intersects the ecliptic. This median line must be conspicuously drawn on all star maps and celestial globes, and the galactic degrees must be numbered thereon. Its distance from a parallel great circle must be accurately maintained all around. For on this distance depends the determination of our own distance from the sidereal centre. All this will necessitate a careful study of the galaxy—its breadth, contours, and real position among the stars.

Fourth. After finding as nearly as possible the line of the nodes of any star on the galactic plane, the next thing to be done is to determine the inclination of its orbit to that plane. Here again we find that the stars easiest to begin with, are those nearest the galactic poles. The planes of their orbits are nearly at right angles to the plane of the galaxy.

Fifth. After the median line of the galaxy has been ascertained and accurately drawn, we can then, and not until then, determine the positions of the galactic poles.

Sixth. After establishing the sidereal poles, it will be important that we construct sidereal globes, having parallel circles concentric with the poles, and also meridian lines. These will assist in the very important work of finding the lines of the nodes, and the

inclinations of the orbital planes. The numbering of the meridians should begin at the intersection of the median line of the galaxy in or near Orion; and the numbers should be identical with those on the median line of the galaxy. The numbering of the parallels should begin at the north galactic pole, and continue to 180° . They should read S. N. P. D., that is, sidereal north polar distance. As the object of these sidereal globes must be to discover the real nature of sidereal motions, so those stars alone which have known proper motions should be admitted on the globes. All else would only confuse the attention and obstruct discovery.

Seventh. To discover which way around the Milky Way revolves, is a grand object. It must revolve in its own plane like a great wheel. This is absolutely necessary from the fact of the intergravitation of the stars. But with the swiftest stellar velocities yet known, say 3000 miles per minute, about 40 years would be required for the galactic stars to move through one second of arc. Therefore we have no present data to learn anything of the galactic revolutions from its own stars. Hence to attain our purpose, we must study the motions of the larger magnitude stars which are situated in the direction of the galaxy. Because many of these must have the same motion as the galaxy itself, especially those far out toward the galaxy; therefore, the more distant stars in the direction of the galaxy, especially those with very slow proper motions, will give us the most information.

Eighth. One of the fundamental elements in sidereal astronomy is the point in space toward which our sun is tending. The high importance of this element is seen in the fact that our sun's

ot be altogether barren; for the facts detected in the discussions may be turned to better account with a better theory.

I have clearly shown in my former paper on "Our Sidereal System" that the point in space toward which our sun is moving, must be sensibly the same during two or three centuries, that is, during all the time in which the positions of the stars have been accurately observed and recorded. I submit the following as being a better guide for finding that point. As the circumference of a circle, more strictly speaking a tangent, is always at right angles to a radius, so the direction of our sun's motion, if its orbit be nearly circular, must be nearly at right angles to the direction toward the centre of our sidereal system. Having found that centre approximately, we now know the zone in the heavens, included in a few degrees on each side of a great circle, where to look for the point in space to which our sun is hastening. But if the sun's orbit be strongly elliptical, and if its present position in that orbit be not near the apsides, then this zone in the heavens must be a little widened. Still, even if widened, we may be happy to know where it lies. It must correspond very nearly with the galaxy. This results from the fact that the direction toward our sidereal centre is nearly perpendicular to the galactic plane. Any point in the constellation Hercules cannot be the point we seek, for it is too far from the galaxy.

Ninth. It will be an assistance to workers in sidereal astronomy to make what may be called sideriums. These should stand in the same relation to our sidereal system, that planetariums hold to our solar system; but their structure must be very different from planetariums. We have all seen during our recent centennial celebration many little flags with their staffs stuck in a central ball; and as their staffs were all of the same length, they formed a globe of little flags. A siderium must have a central ball made of soft wood or cork. In this ball must be stuck thin sharp-pointed rods, and their outer ends, instead of flags, should bear paste-board arrows, representing the directions of stellar flights. On the arrow should be written, or printed, the name of the star, as *61 Cygni*, and the different lengths of the arrows might aid to show their relative velocities. The lengths of the rods should show the relative distances of the stars from the sidereal centre. In the cases of two stars of the second magnitude, one in the direction of our sidereal centre, and the other in apposition, the

lengths of the rods holding the arrows should bear the proportion to each other of about as 1 to 3. The positions and inclinations of the rods should represent the inclinations of the stellar orbits to the galactic plane. The galaxy should be represented by a circular rim held at some distance beyond the arrows, by about 4 supporting radii or spokes.

Tenth. All the star catalogues should be immediately compared to learn the precise amount of their known proper motions and to discover new ones. It is now 28 years since any general work of this kind has been done. Main's catalogue of proper motions was presented to the Royal Astronomical Society in 1850. Since then all the more accurate observations and star catalogues have been made, and therefore, more valuable results might now be obtained. Comparisons of the recorded positions of the southern hemisphere stars are particularly needed; for in that hemisphere but little is known of the stellar motions.

Eleventh. New observations should immediately be made of every star whose proper motion has been announced, or even suspected; this would give accuracy, firmness, and confidence to the data which must be employed in the construction of this new system of sidereal astronomy.

Twelfth. In order to determine which way the galaxy wheels around in its mighty circle, it is of the utmost importance that the positions of many hundreds of its stars should be ascertained with the strictest precision and without any delay. This would be of no benefit to us; but what a rich legacy would such determination be to the next generation, and how memorable would

Thirteenth. Sidereal mathematics will open new problems of exceeding grandeur. In our solar system there is a controlling central sun, and in the mundane and other planetary systems, there is a controlling central planet. But our sidereal system is ruled by no central sun, and its subordinate clusters, such as the Pleiades, Coma Berenicensis, those in Hercules, and many others are equally without a central body. The common centre of gravity in the general system, and the subordinate local centres in the various clusters, are the controlling powers. And they will demand new mathematical processes, and lead to new improvements in mathematical science.

I have demonstrated how a revolving nebulous globe may abandon all its material as rings, which may break up into stars, and how these stars must continue to revolve in the same paths with the rings until they be deflected from these paths by perturbations.

One of the sublime problems of sidereal astronomy will be the amount of centripetal force in the entire sidereal system. This must be told by the centrifugal force, and this latter will have to be determined by the velocities of the stars in their revolutions, and by their distances from the sidereal centre. Judging from the extreme velocities of some stars, velocities of 2000 or 3000 miles per minute, velocities greater than any in our solar system, we must conclude that the common centripetal force toward the centre of our sidereal system is very great.

In our solar system the centripetal force is greater toward the centre of the system; but this is not true in our sidereal system. A particle a hundred or a thousand miles below the earth's surface, is not impelled by gravity toward the earth's centre, as strongly as one on the surface—the same principle rules in our sidereal system.

As the asteroid Pallas has been drawn by perturbation as far as about 35 degrees from its original plane, so it can be shown that perturbations may deflect some stars away from the galactic plane so as to revolve at right angles to it. Other stars may be deflected equally far in the opposite direction. Then these two sets of stars will revolve in opposite directions around the sidereal centre. And when this happens to many stars, the system must become globular in shape, like many nebulae which are distant sidereal systems. The dynamics of such systems must be new

objects of mathematical research, especially in the face of the announcement, that the stability of our solar system depends on the movements of all its members in the same plane, and in the same direction.

When two stars move with high velocities, in contrary directions, around the sidereal centre, and approach near to each other, they will not come in contact, unless their lines of motion meet at the same time in the same point; but they may come indissolubly within each others' gravitating force, and thus form a double star. So triple stars may be formed, and multiple stars, and clusters with hundreds and even thousands of members.

The ultimate revolutions of such clusters, each one around its own centre, and altogether around the general sidereal centre, are absolute necessities. These motions must be the resultants of the prior individual motions, and of the effects of gravity from closer contiguity. To follow them all by calculation will be a new and difficult task. This paper is not designed to pursue these mathematical processes, but only to indicate some of the new and grand problems which sidereal astronomy must open; problems very different from any in our solar system.

DESCRIPTIONS OF NEW SPECIES OF NORTH AMERICAN BEES.¹

BY E. T. CRESSON.

Trigona nigerrima.

♂.—Piceous-black, the pubescence black; sides of face broadly, and the cheeks, pale sericeous; clypeus broad, the apical middle ovoid; tips of mandibles brown; scutellum broadly rounded behind; metathorax smooth and polished; wings fuliginous, apex subhyaline, stigma yellowish; abdomen shining. Length .25 inch.

Hab. Mexico (Sumichrast). One specimen.

Trigona nigra.

♂.—Shining black, the pubescence black; face and clypeus with a pale sericeous pile; flagellum dull testaceous beneath; wings fuscous, whitish at tips; pubescence of legs fuscous; abdomen narrow, polished, more or less brown at base. Length .20 inch.

Hab. Mexico (Sumichrast). Three specimens.

Trigona perilampoides.

♂.—Black, opaque; head and thorax densely punctured, the latter coarsely and confluent so above, clothed with a short pale glittering pubescence; face with a silvery-cinereous pile; labrum, tips of mandibles, and antennæ fulvo-testaceous; narrow lateral margin of mesothorax, apical margin of scutellum, and a round spot on each extreme basal corner, luteous; scutellum subtriangular, flat, projecting over the metathorax, the apex emarginate; tegulae brown; wings smoky, paler at base; legs brown, paler at base and apex; abdomen short, broad, two basal segments shining, piceous, the remaining segments covered with a pale golden-sericeous pile. Length .18 inch.

Hab. Mexico (Sumichrast). Five specimens.

Trigona thoracica.

♂.—Fulvo-testaceous, opaque; vertex, flagellum above, mesothorax, spot on pleura, and base of second segment of abdomen more or less, fuscous or black; the pubescence on vertex and thorax above fuscous, elsewhere it is pale; wings yellowish sub-

¹ The types of the species described in this paper are to be found in the collection of the American Entomological Society.

hyaline, slightly dusky at tips; abdomen short, golden-sericeous. Length .22 inch.

Hab. Mexico (Sumichrast). Two specimens.

Tetrapedia abdominalis.

♀.—Robust, black, the abdomen ferruginous; sides of face, and cheeks with a whitish pubescence; tip of clypeus, and antennæ beneath brown; thorax broad, smooth and shining, lateral angles of prothorax prominent, subspinose; tegulæ piceous; wings fuscous, subhyaline at tips, stigma and nervures pale, the first recurrent nervure uniting with the second transverse cubital nervure; legs black, with the pubescence black, that on tips of posterior tibiæ exteriorly tinged with ferruginous, tibial spurs black; abdomen short, broad at base, shining, the apex fringed with fulvous, and the ventral segments with long white pubescence. Length .30 inch.

♂.—Narrow line on sides of face, most of clypeus, short transverse line above, labrum, mandibles except tips, line on scape beneath, line on each side of prothorax above, postscutellum, and last joint of tarsi, yellowish-white; scutellum with short dense black pubescence; wings paler than in ♀; legs brown, simple, the pubescence black; abdomen flavo-testaceous, shining, the apical segments fringed with white pubescence. Length .25 inch.

Hab. Mexico (Sumichrast). Two specimens. This species resembles *cal-arata* Cress. in color, but has a shorter, broader, and

of second abdominal segment more or less tinged with brown, and never divided.

***Dubas Morrisoni*.**

♂. Black; vertex, thorax above, and first, second, and basal middle of third abdominal segments, clothed with a dense bright lemon-yellow pubescence; elsewhere the pubescence is black; wings fuliginous, violaceous, much darker at base; clypeus smooth, shining, finely and sparsely punctured, depressed. Length .80-.90 inch.

♀.—Like the ♂, but smaller, with the basal half of third segment sometimes yellow. Length .60-.75 inch.

♀.—Face narrow, eyes unusually large; face, vertex, occiput, thorax above, posterior femora, and the first, second, third and basal middle of fourth segments of abdomen, bright lemon-yellow. Length .65 inch.

Hab. Colorado (Mr. H. K. Morrison). Numerous specimens. This is a very handsome species, the yellow being of a bright and beautiful shade.

***Dubas appositus*.**

♂.—Black; face, vertex, occiput, anterior half of mesothorax, continued for a short distance down on each side, clothed with a very pale ochraceous, sometimes nearly white, pubescence; on the scutellum and abdomen above the pubescence is yellow, that on abdomen generally having a brownish shade in certain lights; elsewhere the pubescence is black, except on venter, where the segments are fringed at apex with whitish hair; disk of mesothorax smooth and polished, the pubescence on each side black; clypeus smooth and polished, transversely depressed at tip; the space between the eyes and base of mandibles greater than usual; wings stained with fuscous, darker at base. Length .80-.85 inch.

♀.—Like the female, but smaller. Length .65 inch.

♀.—The pubescence on cheeks, sides of thorax and beneath, and on legs, whitish, and that on abdomen above paler than in the male. Length .70 inch.

Hab. Colorado, New Mexico, Utah, Nevada. Eight specimens. This is closely allied to *borealis* Kirby, but is readily distinguished by the pubescence of the head and thorax anteriorly being whitish, and by that on abdomen above being entirely yellow.

Bombus gelidus.

♀.—Black, the pubescence long and loose; that on occiput, a slight admixture on face and vertex, anterior margin of mesothorax, sides of thorax, scutellum, and first and fourth segments of abdomen, pale yellow or ochraceous; that on second and third segments mostly fulvo-ferruginous, mixed with black on middle and sides; elsewhere the pubescence is black; clypeus sparsely punctured, labrum with fulvous hair; wings stained with fuscous, darker at base and at tip of marginal cell; tarsi pale sericeous, fulvous beneath. Length .70 inch.

Hab. Aleutian Islands (Henry Edwards). One specimen. The pubescence of the abdomen is longer than usual, and the colors are not very decided.

Bombus Edwardsii.

♀.—Black; vertex, thorax above except disk, sides of thorax, first segment of abdomen, basal middle of second, apex of fourth, and sides of fifth clothed with a lemon-yellow pubescence; elsewhere it is black except a slight admixture of yellow on the face above antennæ; disk of mesothorax smooth and polished, with black pubescence on each side; wings stained with fuscous, darker at base. Length .70–.75 inch.

♂.—Black; middle of face, vertex more or less, mesothorax anteriorly, scutellum, sides of thorax, femora beneath, first and fourth segments of abdomen and venter, clothed with pale yellow pubescence; elsewhere it is black; wings subhyaline, dusky on apical margin; tarsi more or less fulvous. Length .45 inch.

♂.—Small, robust, black. Head, thorax except a black band

Hab. California (Crotch). Three specimens. A handsome species.

Bombus Couperi.

♀.—Short, robust, black; vertex, thorax anteriorly, laterally and beneath, scutellum and two basal segments of abdomen, clothed with an ochreous-yellow pubescence, that on the two apical segments fulvous yellow; elsewhere it is black; wings stained with fuscous. Length .65 inch.

Hab. Canada (Mr. Wm. Couper). Two specimens. The black band between the wings is unusually broad.

Bombus Putnami.

♀.—Black; thorax, except a black band between the wings, two basal segments of abdomen above, lateral apical margin of the third, and the venter, clothed with ochreous-yellow pubescence, that on the fifth segment and apex of fourth fulvous-yellow; elsewhere it is black, except a slight admixture of yellow on the face, vertex and femora beneath; face long, clypeus smooth and polished, the space between eyes and base of mandibles greater than usual; wings stained with fuscous. Length .75 inch.

Hab. Colorado—Alpine. One specimen collected by my friend Mr. J. Duncan Putnam in the month of July.

Bombus oregonensis.

♂.—Black, clothed with a long dense pale lemon-yellow pubescence, that on disk of mesothorax and scutellum, and on segments 3-5 of abdomen above, more or less black, and that on the two apical segments fulvous-yellow; wings hyaline, slightly dusky on apical margin. Length .55 inch.

Hab. Oregon (H. Edwards). One specimen.

Bombus bifarius.

♀.—Black; face, vertex, occiput, a broad band on thorax anteriorly extending a short distance down on each side, scutellum except middle, base of femora beneath, sides of basal segment of abdomen, fourth entirely, apical margin of the fifth, and the venter clothed with pale lemon-yellow pubescence, that on the second segment, except basal middle, and the third entirely, of a beautiful orange-fulvous; elsewhere the pubescence is black, except on posterior tibiae and tarsi where it is fulvous; wings pale fuliginous on apical margin. Length .60-.70 inch.

♀.—Like the female, but much smaller, and with the yellow pubescence often much paler. Length .40-.45 inch.

Hab. Colorado, Vancouver's, British America. This is closely allied to *ternarius*, Say, but may be distinguished from that species by the broader black band between the wings, by the yellow on scutellum being divided into two spots, by the black pubescence on basal middle of second abdominal segment, by the fifth segment being fringed at apex with yellow hair, and by the pubescence on posterior tibiae being fulvous.

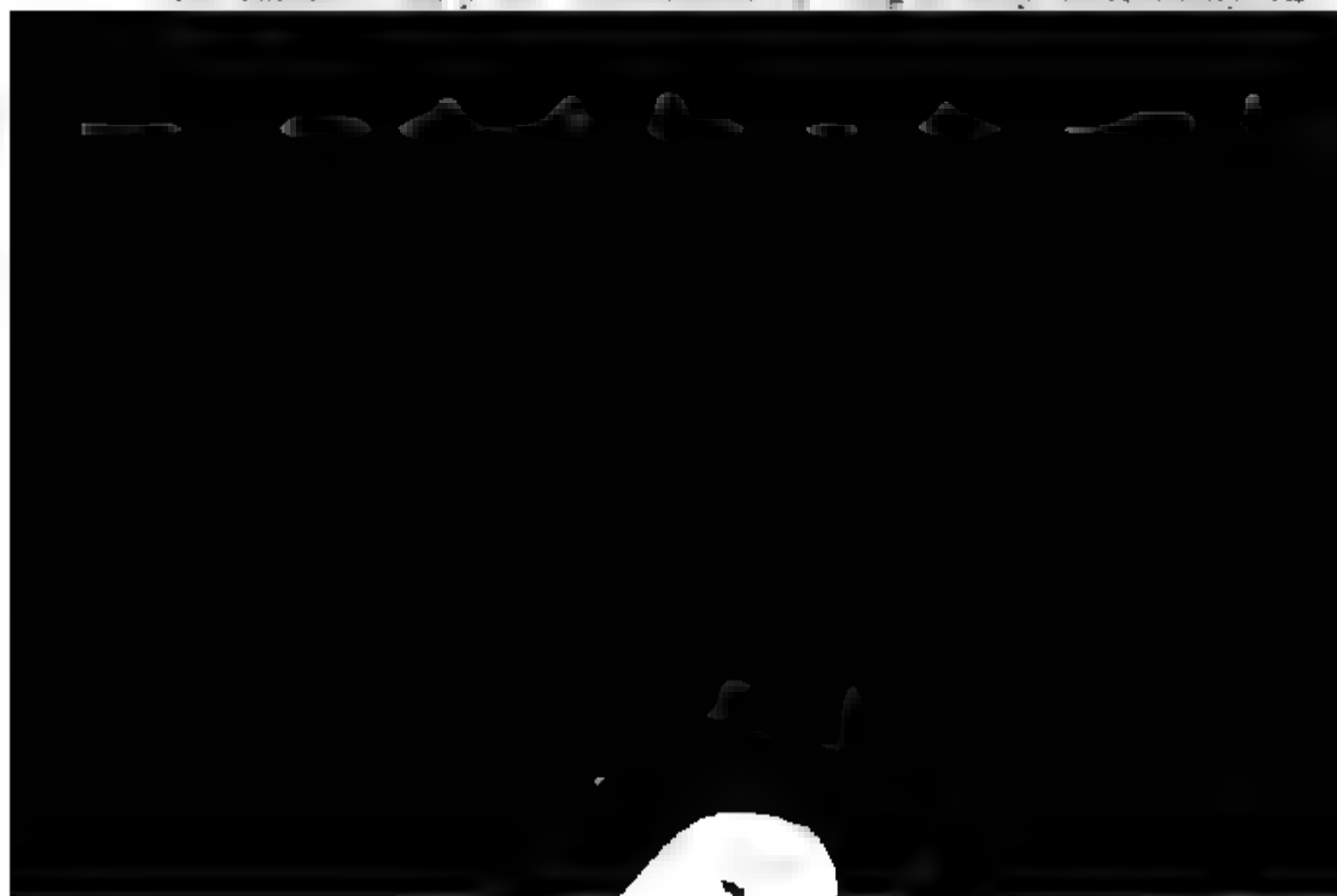
Bombus improbus.

♂.—Black, clothed with a short dense lemon-yellow pubescence, that on disk of mesothorax more or less black, but not extending laterally to the wings; face very narrow, the eyes being unusually large; wings stained with yellowish fuscous; legs clothed with black pubescence, that on femora more or less yellow, basal joint of posterior tarsi fringed behind with pale hair; abdomen with the fourth and fifth segments black, more or less fringed at apex with yellow, apical segments with fulvous-yellow pubescence. Length .60-.70 inch.

Hab. Colorado (Morrison). Two specimens. This has the same form as the ♂ of *pennsylvanicus* De Geer.

Bombus mixtus.

♀.—Black; head and thorax clothed with pale yellow pubescence, intermixed with black on face, vertex and thorax above; between the wings a broad band of black pubescence slightly intermixed with yellow on the sides; wings subhyaline, dusky on



Amabus juxta.

♀.—Black; head, thorax, and two basal segments of abdomen clothed with a dense lemon-yellow pubescence, that on sides of vertex mixed with black; between the wings a distinct well-defined band of black pubescence; wings fuliginous on apical margin; legs with black pubescence, that on femora beneath yellow, and that on tibiae at tips more or less fulvous, tarsi fulvo-sericeous; third and fourth segments of abdomen clothed with dense orange fulvous pubescence, yellow on extreme sides and on venter; two apical segments black. Length .60 inch.

Hab. Colorado (Morrison). Four specimens. This is allied to *flavifrons* Cress., but readily distinguished by the black band between the wings being well-defined, and by the yellow pubescence on mesothorax anteriorly and on scutellum not being intermixed with black as it is in *flavifrons*.

Amabus vancouverensis.

♂.—Black; head, thorax, and legs clothed with lemon-yellow pubescence, slightly mixed with black on sides of face and vertex; between the wings a tolerably well-defined band of black pubescence; wings hyaline, faintly dusky on apical margin; tarsi pale brown; abdomen with the first, basal middle of second and fourth segments and venter with yellow pubescence, that on sides of second and the third segments fulvous, and that on apical segments black, sometimes intermixed with yellow on apical margin and sides; occasionally there is a patch of black pubescence on sides of second segment. Length .45 .50 inch.

Hab. Vancouver's Island (H. Edwards). Ten specimens.

Amabus mexicanus.

♂.—Black, clothed with jet black pubescence; wings uniformly dark fuscous, with a violaceous reflection; posterior tibiae and tips of tarsi brown, basal joint of the latter fulvo-fuscous within; third segment of abdomen clothed with a yellow pubescence. Length .90 inch.

♀.—Like the female, but smaller. Length .65 inch.

Hab. Mexico (Sumichrast). Twelve specimens. A handsome species.

Anthophora capistrata.

♂.—Black; head, thorax, and basal segment of abdomen clothed with dense ochraceous pubescence, that on sides of face, vertex,

and mesothorax slightly mixed with black, that on cheeks and thorax beneath pale ochraceous; clypeus (except a broad transverse black band at base, narrowed laterally, and narrow apical margin), a transverse line above clypeus, sides of face extending narrowly half way up the orbits, labrum except a black spot on each side at base, spot on base of mandibles, and scape beneath, white; wings faintly dusky on apical margin; legs clothed with pale ochraceous pubescence, that on basal joint of posterior tarsi within black, tips of tarsi pale fulvous, intermediate tarsi slender, simple, basal joint of posterior pair robust, simple; abdomen black, with a slight bluish reflection, apical margin of segments 2-6 dull whitish, with a rather narrow even band of appressed whitish pubescence, apical segment bilobate at tip; extreme sides of venter with long whitish pubescence. Length .50 inch.

Hab. Texas (Belfrage). Two specimens. In this and all the following species described under this genus, the second submarginal cell of anterior wings is, unless otherwise mentioned, subtriangular and receives the first recurrent nervure at or about the middle.

Anthophora urbana.

♀.—Black; clothed with a whitish pubescence, that on vertex and thorax above tinged with ochraceous and mixed with black; clypeus confluent punctured and depressed at tip; wings hyaline, faintly dusky on apical margin; legs with white pubescence long on the femora, tip of basal joint of posterior tarsi with a tuft of black hair, the pubescence on the inside fuscous; first segment of abdomen with pale ochraceous pubescence, apical margin of

pubescence, that on scutellum and metathorax rufo-ferruginous; wings slightly smoky, subiridescent; legs black, clothed with black pubescence, long on femora and white on coxæ and trochanters, four anterior tibiae above pale, a small silvery white spot on tip of posterior femora above; abdomen with a slight bluish iridescence, basal segment clothed with a fulvous pubescence, apical margin of segments 1-4 narrowly yellowish-white, extreme sides of the segments with a patch of white pubescence, that on apical segment black; ventral segments fringed with white hair, length .45 inch.

♂.—Clypeus, line above, sides of face, labrum except two spots at base, scape beneath, and narrow apical margin of abdominal segments 1-5 white; legs rufo-piceous, with short black pubescence, that on coxæ, and tips of four anterior tibiae white; otherwise as in ♀. Length .45 inch.

Hab. Porto Rico (Mr. Leopold Krug). Two specimens. This is closely allied to *tricolor* Fab.

Anthophora affabilis.

♀.—Black; head, thorax, legs, and basal segment of abdomen clothed with a dense cinereous pubescence, that on vertex tinged with ochraceous and that on thorax above slightly so; wings faintly dusky, tibiae and basal joint of the tarsi within clothed with black pubescence, that on the latter above black, more or less mixed with white at base; abdomen smooth and shining, with a slight bluish iridescence, apical margin of second and third segments narrowly fringed with white pubescence, fourth and fifth segments with sparse long white hair, more dense on apex of fifth segment which has a patch of black pubescence on apical middle; ventral segments fringed with long white pubescence. Length .60-.65 inch.

♂.—Closely resembles the ♀; sides of face, clypeus, line above, labrum except two black dots at base, and scape beneath, yellowish-white, intermediate tarsi long and slender, terminal joint fringed laterally with black hair; segments 2-6 fringed at apex with white pubescence, broadly so on 5 and 6; otherwise as in ♀. Length .60 inch.

Hab. Texas (Belfrage). Three specimens.

Anthophora similima.

♀.—Black, head, thorax, legs, and base of abdomen clothed with a long whitish cinereous pubescence, that on vertex and

thorax above more or less mixed with black; a subanceolate mark on each side of the face, clypeus except two spots at base, labrum and scape beneath pale yellow or yellowish-white; wings hyaline, faintly dusky on apical margin; legs clothed above with white pubescence, that beneath except on coxæ, black, middle joints of tarsi fulvous, intermediate pair long and slender, ciliated with long fulvous pubescence, the first and last joints black, the latter ciliated laterally with black hair, posterior legs simple; abdomen with the two basal segments clothed with whitish cinereous pubescence, the two apical segments more or less silvery cinereous, third, fourth, and fifth segments clothed with black pubescence, slightly mixed with pale on apical margin; seventh segment subdentate at tip. Length .50 inch.

Hab. Colorado (Morrison). Four specimens. This is closely allied to *ursina* Cress., the form of the legs being the same, especially that of the intermediate tarsi.

Anthophora pacifica.

♂.—Black, clothed with a cinereous pubescence, more or less intermixed with black, especially on thorax above; subanceolate mark on sides of face, clypeus except two spots at base, labrum except two spots at base, and scape beneath pale yellow; wings subhyaline; legs clothed with black pubescence, very long on femora beneath, that on coxæ and trochanters long and white, tips of tibiae with short white pubescence, the tarsi fringed with long white hair, intermediate tarsi long and very slender, fringed behind with long white hair, intermixed with black on basal joint; abdomen clothed with long cinereous pubescence, but a narrow

of abdomen shining, clothed with a very short black pubescence, the apical margin with a more or less interrupted fringe of whitish hair; extreme sides of abdomen, apex of fifth segment except middle and sides of ventral segments clothed with long white pubescence. Length .50 inch.

♂.—Resembles the ♀; lanceolate mark on sides of face, clypeus except lateral suture, labrum except two spots at base, and scape beneath yellow or yellowish-white; intermediate tarsi long, slender, simple, basal joint of posterior pair with a short, stout tooth on inner edge; abdominal segments 1, 2, and 6 with cinereous pubescence, sometimes that on 3–5, which is generally black, is more or less intermixed with cinereous. Length .50 inch.

Hab. California, Nevada (H. Edwards). Seven specimens.

Anthophora mucida.

♀.—Black, clothed with an ochreo-cinereous pubescence, very dense on thorax; wings subhyaline, second submarginal cell subquadrate, the first recurrent nervure uniting with the second transverse cubital nervure; the pubescence on basal joint of the tarsi mostly black; the pubescence on base, sides, and apex of abdomen long, that on third, fourth, and fifth segments more or less black, the fifth segment having a fringe of dense ochraceous pubescence at tip; ventral segment fringed with long pale pubescence. Length .55 inch.

Hab. Colorado (Morrison). One specimen. This species resembles *Edwardsii*, but is easily separated by the form of the second submarginal cell which is normal in that species, being subtriangular in shape and receiving the recurrent nervure at about the middle.

Anthophora miserabilis.

♂.—Black; the entire insect clothed with a cinereous pubescence, intermixed with black on vertex and thorax above, that on the abdomen above shorter and thin, not concealing the surface; narrow line on sides of face, hooked beneath, and a large subtrefoil mark on clypeus, yellowish-white; antennæ entirely black; wings hyaline, second submarginal cell narrow, subquadrate, receiving the first recurrent nervure at the tip and very nearly uniting with the second transverse cubital nervure; legs slender and simple. Length .50 inch.

Hab. California (H. Edwards). One specimen.

Anthophora Morrisoni.

♂.—Black; head, thorax, legs, and basal segment of abdomen clothed with a dense ochraceous pubescence, nearly white on cheeks and thorax beneath, that on thorax above sometimes fulvo-ochraceous; sides of face, clypeus except a dot on each side, a transverse line above, and the scape beneath white; wings hyaline, second submarginal cell subquadrate, being slightly narrowed above, and receiving the first recurrent nervure near the tip; legs slender and simple, the pubescence on posterior legs mostly black; abdomen shining black, the first segment clothed with ochraceous pubescence, and the apical segment has a more or less conspicuous silvery pile. Length .50 inch.

Hab. Colorado (Morrison). Four specimens.

Anthophora Crotchii.

♂.—Black; head, thorax, legs, and base of abdomen clothed with a fulvo-ochraceous pubescence; sides of face, clypeus, labrum, mandibles except tips, and scape beneath, yellow; wings hyaline, slightly dusky at tips; intermediate tarsi very long and slender, pale brown, fringed with long pale hair, the apical or claw joint black, and ciliated laterally with long dense black hair, like a feather; abdomen with short black pubescence, except on the two basal segments where it is ochraceous, and longer on the first, apical segment fringed with white pubescence. Length .50 inch.

Hab. California (Crotch). One specimen. The apical joint of intermediate tarsi is more broadly ciliated than any species known to me.

the two apical segments clothed with black or fuscous pubescence, sometimes with a mixture of pale on the sides; in one specimen there is an indistinct oblique line of pale pubescence on each side of third segment and a narrow line on lateral apical margin of fourth segment; venter entirely black. Length .60 inch.

♂.—Pubescence of head, thorax above and basal segment of abdomen bright ochraceous; clypeus, labrum, and spot on mandibles, yellow; antennæ as long as head and thorax, black, rufopiceous beneath, third joint about one-third the length of fourth; disk of mesothorax and scutellum above, and pleura at sides and beneath, clothed with black pubescence, a slight mixture of pale pubescence beneath tegulæ; tegulæ dull testaceous; wings pale fuscous; legs clothed with short black pubescence, that on anterior tibiæ and tarsi, and all the coxæ, golden ochraceous, and that on tips of four posterior tibiæ ochraceous, tips of tarsi ferruginous, tibial spurs pale, intermediate tarsi long and rather slender; line at extreme base of second segment and a short oblique line on each side of third segment of short dense ochraceous pubescence, extreme sides of sixth segment with a short acute spine, tip of apical segment golden above; venter shining black, piceous at base. Length .55 inch.

Hab. Georgia (Morrison, Ridings). Ten specimens. The pubescence on mesothorax of ♀ is sometimes entirely black.

Melissodes morosa.

♀.—Black; head clothed with ochraceous pubescence which is mixed with black on vertex and occiput; thorax clothed with a short dense black pubescence, that on prothorax above and a slight admixture on metathorax ochraceous; disk of mesothorax nude, sparsely punctured; wings short, subhyaline, nervures fuscous, second submarginal cell shorter than first, second subtruncate at apex and narrowed nearly two-thirds towards marginal; legs clothed with short black pubescence, the posterior tibiæ and tarsi with long dense yellow pubescence, which on the tarsi within is fuscous; abdomen clothed with black pubescence, that on lateral margin of basal segment ochraceous; narrow basal margin of second segment, a narrow suboblique line on each side a little behind the middle, and broad apical margin of third and fourth segments, covered with a dense appressed ochraceous pile; two apical segments fringed with fuscous pubescence; venter with

black pubescence, apical margin of the segments dull testaceous. Length .50 inch.

Hab. Mexico (Sumichrast). One specimen.

Melissodes monteruma.

♀.—Black, shining; face, clypeus, and labrum with short pale pubescence slightly mixed with black, that on vertex and occiput long and black, and on cheeks long and white; tips of mandibles fulvous; anterior half of mesothorax and the pleura laterally and beneath clothed with dense black pubescence, that on mesothorax posteriorly, scutellum, and metathorax fulvous; tegulae fulvo-testaceous; wings subhyaline, dusky at tips, nervures black, second submarginal cell small, narrow, about one-third the length of first, the first recurrent nervure uniting with the second transverse cubital nervure, third submarginal broadly rounded at tip and narrowed one-third towards marginal; pubescence of legs entirely black, tips of tarsi ferruginous; abdomen shining, basal segment with a long thin pale fulvous pubescence, and at sides of two apical segments a tuft of whitish pubescence; venter fringed laterally and at apex of segments with pale pubescence. Length .55 inch.

♂.—Labrum whitish; antennae rather longer than the body, robust, black, flagellum dull fulvous beneath, third joint very short about equal with the second, the fourth twice as long as the three last joints taken together. The black pubescence on mesothorax

♂.—Clypeus, labrum, and spot on base of mandibles, yellowish; antennæ as long as head and thorax, fulvous, brown above, the third joint about one-fourth the length of fourth; legs with mixed fuscous and ochraceous pubescence, tarsi with black hair, apical joints ferruginous; base and sides of two basal segments of abdomen and extreme sides of third segment with whitish pubescence, an indistinct oblique line of pale fuscous pubescence on each side of third and fourth segments; sixth segment with an acute tooth on each extreme side. Length .50 inch.

Hab. Georgia (Bidings, Morrison). Nine specimens. The ♀ of this species closely resembles that of *desponsa* Smith, which, however, has the pubescence of thorax beneath and of four anterior legs entirely black.

Chalcidodes nigrifrons.

♀.—Small, robust, black, clothed with black pubescence, that on occiput, thorax above, and extreme base of abdomen pale ochraceous, antennæ very short, flagellum subtestaceous beneath; a small patch of pale ochraceous pubescence beneath tegulae, which is pecuni; wings hyaline, nervures black; second submarginal cell small, less than half the length of first, receiving the first recurrent nervure very near the apex, third submarginal about three times longer than second, rounded at tip and narrowed one-half towards marginal; pubescence of legs entirely black; abdomen shining, the pubescence, except on basal segment, short and black. Length .40 inch.

Hab. California (Crotch). Three specimens.

Chalcidodes Edwardsi.

♂.—Black; head, thorax, legs, and base of abdomen clothed with a dense fulvo-ochraceous pubescence, which is paler on sides and beneath; clypeus and labrum yellowish; antennæ reaching beyond first abdominal segment, entirely black, crenulated toward tip, third joint shorter than first, wings hyaline, nervures fuscous, second submarginal cell more than half the length of first, the third broadly truncate at tip and then suddenly narrowed one-half towards marginal; tarsi long and slender, especially the intermediate pair, simple, the basal joint of posterior pair fringed with long pale hair, abdomen shining, basal segment densely clothed with a long ochraceous pubescence, which extends more or less on base and sides of second segment; remaining segments above

clothed with a short black pubescence, longer at sides and at tip; sometimes the fourth and fifth segments have each a narrow, indistinct, subapical fascia of white pubescence; venter clothed with pale pubescence at extreme sides of basal segments. Length .50-.55 inch.

Hab. California (H. Edwards). Six specimens.

Melissodes californica.

♂.—Black; head, thorax, legs, and base of abdomen densely clothed with a pale yellowish-white pubescence; clypeus and labrum yellow; antennæ reaching to tip of first abdominal segment, entirely black, the apical joints subcrenulated, third joint long, attenuated towards base, rather longer than first and second taken together, joints of the flagellum long and flattened and subcarinate laterally; tegulæ dull testaceous; wings hyaline, nervures fuscous, second submarginal cell half the length of first, third shorter than first, subtruncate at tip, and narrowed less than one-half towards marginal; intermediate tibiæ dilated and subdentate beneath, their tarsi long and slender, basal joint long, black, slightly curved, dilated near base beneath and attenuated to tip, and fringed beneath with dense fulvous hair, remaining joints elongate, ferruginous; basal joint of posterior tarsi narrow, flat, black, fringed beneath with short and at tip with long fulvous hair, at the tip within a slender incurved acute tooth, apical joints ferruginous; abdomen shining black, two basal segments clothed with pale yellowish pubescence, long on first segment, remaining segments and venter with short black pubescence, that on apex of first segment or less fuscous. Length .50 inch.

nce, tarsi fulvous, the basal joint of posterior pair fringed with long yellowish hair; intermediate tibiæ short, dilated and toothed beneath towards base and with a short acute spine at tip above, most hidden by the dense white pubescence, their tarsi long and slender, the basal joint subfusiform, more strongly narrowed towards tip, which is slightly dilated and produced behind into a prominent, somewhat curved subacute tooth, remaining joints long and slender; abdomen shining at tip, two basal segments with dense ochraceous pubescence, shorter and paler on second segment, remaining segments with black pubescence, interspersed with long scattering pale hair, sixth segment generally with a narrow fringe of whitish pubescence; sometimes segments 3-6 have each an indistinct subapical fascia of cinereous pubescence, more distinct when viewed in certain lights; venter with mixed pale and black pubescence. Length .50 inch.

Hab. Colorado (Morrison). Six specimens. Allied to *californica*, but smaller, and easily separated by the form of the intermediate tarsi.

Malisodas frater.

♂.—Black; head and thorax clothed with a dense cinereous pubescence, more or less tinged with ochraceous above and pale beneath; clypeus and labrum yellow; antennæ three-fourths the length of the body, entirely black, crenulated towards apex, third joint very short, about twice the length of second; wings hyaline, with fuscous nervures, second submarginal cell large, two-thirds the length of first, the third broadly truncate at tip and narrowed more than one-half towards marginal; legs thickly clothed with white pubescence, tarsi fulvous at tips, clothed at base beneath with dense golden hair, the posterior pair fringed with long pale hair, intermediate legs simple, the basal joint of their tarsi long and narrow; abdomen rather shining, with a changeable pale subpruinose pile, first and second segments with a thin pale pubescence, longer on the first, segments 3-6 each with a more or less distinct fascia of whitish pubescence, more dense 5 and 6, sides of apical segments with long pale hair; venter piceous, almost nude. Length .50 inch.

Hab. Colorado (Morrison). Six specimens. This is closely allied to *honestus* Cress., from Texas, which has the abdomen distinctly banded, the labrum black, and the antennæ shorter, with the third joint longer than in the present species.

Melissodes lepida.

♂.—Black; head, thorax, legs, and base of abdomen clothed with an ochraceous pubescence, that on thorax above more or less tinged with fulvous, and very dense; clypeus and labrum pale yellow; antennæ rather longer than head and thorax, entirely black, subcrenulated towards tip and flattened and subcarinate laterally, third joint three times longer than second and less than half the length of fourth; wings hyaline, with pale fuscous nervures second submarginal cell half the length of first, receiving the recurrent nervure very near the tip, the third broadly subtruncate at tip and narrowed nearly one-half towards marginal; tarsi except base fulvous, intermediate pair long and very slender, the basal joint narrowed to tip, slightly twisted and curved, basal joint of posterior pair fringed with long yellowish hair; abdomen shining, two basal segments clothed with pale yellow pubescence short and paler on the second, segments 2-6 each with a narrow, even, apical fringe of pale cinereous pubescence, sides of apical segments with a few long whitish hair; venter piceous, almost nude. Length .45 inch.

Hab. Texas (Belgrave); Colorado (Morrison). Three specimens. Also closely allied to *honesta*, but smaller and with differently formed intermediate tarsi.

Melissodes speciosa.

♀.—Large, black; face with a short griseous pubescence, occiput and thorax with a dense fulvo-ochraceous pubescence; clypeus coarsely and confluent punctured; mandibles fulvous near tips;

Hab. Colorado (Bidings, Morrison). Five specimens. A very handsome species, having the abdominal fasciae broad and distinct.

Salicodan dilecta.

Black. Head, thorax, and base of abdomen clothed with a dense cinereous pubescence, strongly tinged with yellow above; apex and labrum yellowish-white, tips of mandibles pale, antennae as far as the length of body, entirely black, subcrenulated towards tip, third joint about three times the length of second; wings slightly tinged with yellowish, nervures pale fuscous, second submarginal cell quadrate, more than half the length of first, the third broadly truncate at tip and narrowed about one half towards marginal; legs clothed with pale ochraceous pubescence, dense and fuscous on base of tarsi beneath; intermediate tarsi slender, the basal joint slightly curved, posterior pair fringed with long pale yellowish hair, first segment of abdomen clothed with long yellow pubescence, remaining segments with a very short cinereous pile, becoming more dense before apex, and forming a more or less distinct white band, and interspersed with longer black and black scattering hairs, venter brown, the sides of the segments fringed with pale pubescence. Length .45-.50 inch.

Hab. Texas (Beltinger), Colorado (Bidings). Three specimens. May be the ♀ of *apicicornis*.

Salicodan sumpta.

Black, head clothed with a dense cinereous pubescence; eyes deeply and confluent punctured, apical half of mandibles black. Thorax and basal segment of abdomen with a short cinereous pubescence, very dense on thorax, entirely conceal- ing surface, tegulae pale fulvous; wings pale fuliginous, with a convex reflection, nervures black, second submarginal cell less than half the length of first, the third broadly rounded at tip, and narrowed one half towards marginal, legs clothed with dark cinereous pubescence, black on basal joint of anterior tarsi, abdomen with four narrow fasciae of dense appressed white pubescence, one on second segment, and one each on third and fourth, that on the latter dilated laterally, two apical segments and venter clothed with black pubescence. Length .70 inch.

Labellum, labrum, and spot at base of mandibles yellowish-white, antennae scarcely as long as head and thorax, black, apical joint long, acuminate and acute at tip, three basal joints brownish,

pubescent, the third clavate, about equal in length with the fourth; thorax as in ♀; wings subhyaline, fuliginous and subviolaceous on apical margin; legs clothed with fulvous pubescence, tarsi simple and subrobust; the four white bands on abdomen less distinct, subinterrupted, and sometimes subobsolete; sides of sixth segment with a short acute tooth. Length .55 inch.

Hab. Georgia (Morrison). Three specimens. A very pretty species. The ♂ antennæ are acutely pointed at tip.

Melissodes georgica.

♂.—Black; head, thorax, and base of first segment of abdomen clothed with a short dense ochraceous pubescence; clypeus, labrum, and base of mandibles yellow, the latter fulvous near tips; antennæ as long as head and thorax, third joint twice the length of second, the flagellum dull fulvous beneath; wings tinged with yellowish, the apical margin dusky and subviolaceous, nervures fuscous, second submarginal cell large, three-fourths the length of first, the third rounded at tip and narrowed one-half towards marginal; legs clothed with dull ochraceous pubescence, that on four posterior tibiæ and tarsi fuscous or black, extreme tips of their tibiæ with a tuft of whitish pubescence, tarsi simple, subrobust, tips dull ferruginous; apex of abdomen with rather long black pubescence, the ochraceous pubescence on base of first segment extends narrowly down on the sides of second and third segments; a narrow band at base of second segment and a broader band on third and fourth, slightly oblique laterally and subinterrupted medially of appressed white pubescence; there is a slight indication of an oblique line of pale pubescence on sides of second seg-

margin, nervures fuscous or black, second submarginal cell nearly as long as the first, the third rounded at apex and narrowed two-thirds towards marginal; the pubescence on four anterior tarsi and on posterior pair within is fuscous or black; abdomen shining, extreme base thinly clothed with a yellowish pubescence, extreme base of third segment occasionally with a whitish band, two spots or short lines on sides of second segment, a narrow band near apex of third, slightly interrupted medially and a broad band at tip of fourth segment, of short appressed pale fulvous pubescence; sides of apical segments and ventral segments fringed with yellow pubescence. Length .55 inch.

♂.—Closely resembles the ♀; clypeus, labrum, and spot at base of mandibles, yellow; antennae rather longer than head and thorax, third joint a little longer than second, flagellum pale fulvous or yellow beneath; the black pubescence on disk of mesothorax and scutellum more dense; third submarginal cell narrowed three-fourths towards marginal; pubescence on legs entirely bright fulvous or yellow, tarsi simple, tips ferruginous; base and sides of first segment of abdomen, sides of second and a short lateral subapical line, a band on third, interrupted medially, and a band on fourth and fifth, all of dense ochraceous pubescence; sixth and seventh segments each with a short tooth on extreme sides; ventral segments fringed with ochraceous or yellow hair. Length .55 inch.

Hab. Colorado (Ridings, Morrison). Ten specimens.

Heliozelus petalca.

♀.—Black; head clothed with short dense cinereous pubescence, that on occiput fulvous; clypeus finely punctured; mandibles with a pale spot near base; flagellum dull testaceous beneath; thorax clothed with a short dense ochraceous pubescence, more or less tinged with fulvous above, that on disk of mesothorax and scutellum black; tegulae dull testaceous; wings subhyaline, tinged with yellowish, nervures pale fuscous, second submarginal cell nearly as long as first, the third broadly rounded at tip and narrowed one-half towards marginal; legs clothed with ochraceous or pale fulvous pubescence, long and dense on posterior tibiae and tarsi, tips of tarsi ferruginous; base and sides of first segment of abdomen and sides of apical segments clothed with ochraceous pubescence, broad apical margin of segments 2-4 and base of second

narrowly, densely clothed with a short appressed cinereous pile; apical margin of first segment narrowly testaceous; ventral segments fringed with yellow or ochraceous pubescence. Length .50 inch.

Hab. Georgia (Morrison). Three specimens.

Melissodes montana.

♀.—Black; head densely clothed with pale cinereous pubescence, that on occiput mixed ochraceous and black; mandibles fulvous near tips; thorax densely clothed with a long ochraceous pubescence, tinged above with fulvous, that on disk of mesothorax and scutellum short and black; tegulae piceous; wings hyaline, dusky on apical margin, nervures fuscous, second submarginal cell three-fourths the length of first, the third long, rounded at tip, and narrowed one-half towards marginal; legs clothed with ochraceous pubescence, that on posterior tibiae and tarsi long and dense, tips of four posterior tibiae and basal joint of their tarsi and of the posterior pair within clothed with fuscous or black; abdomen with base and sides of two basal segments, and extreme sides of remaining segments, clothed with ochraceous pubescence, segments 2-4 each with a band of dense appressed golden ochraceous pubescence, broadest on 4, and more or less interrupted on 2; apical segments with black or fuscous pubescence; venter piceous, clothed with black pubescence. Length .50 inch.

♂.—Head, thorax, base, and sides of abdomen clothed with

Ichneumon suffusa.

♂. — Black, head clothed with cinereous pubescence, that on labrum and clypeus ochraceous; anterior margin of clypeus, most of labrum and base of mandibles pale ferruginous, a yellowish line on mandibles near tips; thorax clothed with a short dense ochraceous pubescence, pale on sides and beneath, and tinged with fulvous above, that on disk of mesothorax and scutellum sparse and black; tegulae pale testaceous; wings hyaline, slightly dusky on apical margin, nervures fuscous, costal nerve ferruginous, venation as in *mediana*; legs clothed with ochraceous pubescence long and dense on posterior tibiae and tarsi and fulvous within, base of tarsi ferruginous, base and sides of first abdominal segment clothed with ochraceous pubescence, a white band at base of second segment and a very broad band of short dense appressed cinereous pale on apex of segments 2-4, two apical segments clothed with fulvous pubescence paler laterally, apical margin of fifth segment narrowly whitish; venter with fulvous pubescence, apical margin of the segments fulvo-testaceous. Length .60 inch.

♀. — Pubescence paler and more dense on head, clypeus, labrum, and base of mandibles yellowish, antennae rather longer than second thorax, third joint three times longer than second and about half the length of fourth, flagellum fulvous beneath, wing nervures fulvous, legs simple, clothed with ochraceous pubescence, that on tarsi beneath fulvous, abdomen much as in ♂ except that the band on fourth segment is narrower, and the fifth has a similar band, apex with fulvous pubescence, the sixth segment having a stout acute tooth at extreme apex. Length .45 inch.

Hab. Texas (Belfrage, Hedgesbrodt). Four specimens. The cinereous bands on abdominal segments 2-4 of ♀ are very broad, covering nearly the entire upper surface.

Ichneumon fimbriata.

♂. — Black, head and thorax clothed with pale ochraceous or cinereous pubescence, which on disk of mesothorax and scutellum sparse and mixed with black, mandibles with a yellowish stripe near tips, flagellum subtestaceous beneath, tegulae piceous, wings hyaline on apical margin, nervures black, second submarginal cell about length of first, basal nerve very oblique, third submarginal obsolete at tip and narrowed one half towards marginal, legs clothed with fulvous pubescence, long and dense on posterior

pair; abdomen with basal and lateral margins of first segment, extreme basal margin of second, and narrow apical margin of segments 2-4 fringed with whitish pubescence, elsewhere the pubescence is fuscous or black. Length .45 inch.

♂.—Closely resembles the ♀; clypeus and sometimes a spot on labrum yellowish; antennæ two-thirds the length of body, third joint scarcely twice the length of second, flagellum fulvous beneath; pubescence on thorax much longer, disk of mesothorax and scutellum shining and sparsely punctured; pubescence of legs paler, tarsi slender, simple, ferruginous at tips; fifth segment of abdomen fringed at apex with white pubescence similar to that on fourth, two apical segments each with a short acute tooth on extreme sides, sides of venter with long whitish hair. Length .45 inch.

Hab. Texas (Belfrage). Four specimens. This is allied to *rivalis* Cress.

Melissoctes agilis.

♂.—Small, black, clothed with a pale ochraceous or cinereous pubescence, dense on thorax; clypeus, labrum, and spot on base of mandibles pale yellow; mandibles dull ferruginous at tips; antennæ nearly as long as the body, fulvous, darker above, three basal joints black, third joint a little larger than second; wings whitish-hyaline, with pale testaceous nervures, second submarginal cell half the length of first, the third rounded at tip and narrowed one-half towards marginal; legs clothed with short cinereous pubescence, tarsi slender, simple, pale ferruginous at

dark, darker on apical margin, nervures fuscous, second submarginal cell more than half the length of first, the third rounded at tip and narrowed one-half towards the marginal, four anterior legs with mixed fuscous and ochraceous pubescence, posterior tibiae and tarsi with long dense fulvous pubescence, which is darker within; abdomen shining, base and sides of first segment, with cinereous pubescence; narrow band at extreme base of second segment, another, slightly arcuated, across the middle, a broad band near base of third, and another on apex of fourth, sometimes interrupted on posterior middle, composed of short dense appressed whitish pile; apex and venter with black pubescence, but on the sides of the latter generally mixed with white. Length .6 inch.

♂.—Resembles the ♀ in color of pubescence and ornamentation of abdomen; clypeus, labrum, and base of mandibles pale yellowish; antennae two-thirds the length of body, third joint scarcely like the length of second, flagellum fulvous beneath; legs clothed with ochraceous pubescence, that on tarsi beneath golden, tarsi simple, pale ferruginous at tips; sometimes the fifth abdominal segment has an indistinct band of pale hairs; two apical segments each with a short lateral tooth; sometimes the apical margin of the segments are more or less testaceous. Length .45 inch.

Hab. Georgia, Illinois. Twenty specimens.

Chimodes confusa.

♀.—Black; head and thorax clothed with a dense pale ochraceous pubescence, slightly mixed with black on vertex, occiput, and thorax beneath; on disk of mesothorax and scutellum the pubescence is sparse and black, the former smooth, polished, sparsely punctured; tegulae picuous; wings hyaline, slightly dusky on apical margin, nervures fuscous, second submarginal cell three-fourths the length of first, the third rounded at tip and narrowed more than one half towards marginal; legs clothed with black pubescence, mixed with pale ochraceous at base of four anterior tibiae and apex of posterior femora, posterior tibiae and outside of the tarsi clothed with a long dense yellow pubescence; abdomen clothed with short black pubescence, longer on apical segments, first segment with a long sparse pale pubescence at base, segments second and third with a broad band of short dense appressed pubescence, interrupted on second and third segments, base of second

sometimes with a narrow band at base; venter with black or fuscous pubescence. Length .45-.50 inch.

♂.—Black; head, thorax, and base of abdomen clothed with a long dense whitish pubescence, more or less tinged above with ochraceous; clypeus yellowish; antennæ nearly as long as the body, entirely black, third joint a little larger than second; pubescence of legs entirely pale ochraceous, tips of tarsi ferruginous, tibial spurs whitish; apical margin of abdominal segments whitish, and having a band of pale pubescence, sixth and seventh segments each with a short tooth on each extreme side, generally concealed by the pubescence; venter piceous, the pubescence sparse and pale, apical margin of the segments narrowly testaceous. Length .40-.43 inch.

Hab. Colorado (Ridings, Morrison). Twelve specimens.

Melissodes perplexa.

♀.—Black, shining; head and thorax clothed with cinereous pubescence, that on anterior margin of occiput, mesothorax except anterior margin and scutellum, erect and black; disk of mesothorax almost nude and sparsely punctured; mandibles with a yellowish stripe near apex; tegulæ piceous; wings hyaline, slightly dusky on apical margin, nervures black, third submarginal cell rounded at apex and narrowed one-half towards marginal; legs with black or fuscous pubescence, posterior tibiæ and outer side of basal joint of their tarsi pale ochraceous; base of first segment and sides of all the segments beneath with cinereous pubescence, a cinereous band on middle of second and third segments, suboblique on the sides and more or less interrupted on second, and a band of same

Mesodes condigna.

♀. — Robust, shining black; head clothed with short whitish pubescence, very short on clypeus, the disk of which is nude, a tuft of long black hair behind ocelli; mandibles near tips and flagella beneath yellowish; prothorax, lateral and posterior margins of mesothorax, metathorax, and large patch beneath wings clothed with griseous or whitish pubescence, elsewhere it is short and black, a slight admixture of pale hair on mesothorax anteriorly; disk of mesothorax and scutellum shining, sparsely punctured and nude; tegulae piceous; wings tinged with yellowish and with golden reflection, pale dusky on apical margin, nervures fuscous, second submarginal cell small, scarcely half the length of first, third submarginal as long as first, rounded at apex and narrowed one-half towards marginal; legs clothed with mixed fuscous and pale pubescence, that on posterior tibiae and tarsi yellow, fulvous above, abdomen shining, finely punctured, subiridescent; base of first segment with a thin pale pubescence; a narrow band at base of second segment dilated on extreme sides, a broad band at base of third, a broad band at apex of fourth, more or less interrupted medially, and a spot on each side of fifth, of short dense appressed cinereous or pale ochraceous pubescence; apical margin of the segments sometimes narrowly pale testaceous; lateral apical margin of ventral segments fringed with whitish hair. Length .35 inch.

Det. Illinois, Kansas. Two specimens.

Mesodes Stretchii.

♀. — Black; head and thorax clothed with dense griseous pubescence, clypeus nude, densely punctured; labrum with fulvous pubescence, mesothorax very densely and finely punctured, the pubescence short and not very dense, that on pleura long, dense, and nude, tegulae piceous; wings subhyaline, nervures black, second submarginal cell less than one-half the length of first, the first truncate at tip and narrowed one-half towards marginal; legs clothed with pale ochraceous pubescence, long and dense on posterior tibiae and tarsi; abdomen nearly nude, a little griseous pubescence at base of first segment, apical margin of segments 2 and 3 narrowly whitish, the base of 2-5, and apex of 5 with a narrow band of appressed pale ochraceous pile, indistinct on base of 2 and 5, apical segment with fulvous pubescence; venter fringed with long pale pubescence. Length .50 inch.

Hab. California (R. H. Stretch). One specimen. A very distinct species.

Melissodes actiosa.

♀.—Black; head and thorax clothed with griseous pubescence, sparse on face and disk of mesothorax, which latter is opaque and impunctured; tegulae rufo-piceous; wings hyaline, nervures fuscous, second submarginal cell small, less than half the length of first, the third truncate at tip and narrowed one-half towards marginal; legs with pale ochraceous pubescence, long and dense on posterior tibiae and tarsi; abdomen with short black pubescence, a few scattered pale hairs on base of first segment, a broad band of appressed cinereous pubescence on apex of segments 2-4, generally interrupted on middle of 2, and a band of pale fulvous pubescence on apex of 5; ventral segments fringed with griseous pubescence. Length .45 inch.

Hab. California (H. Edwards). Three specimens. This has the mesothorax and scutellum opaque and impunctured.

Melissodes donata.

♀.—Small, black; head and thorax clothed with a short, not very dense griseous pubescence, that on vertex, mesothorax, and scutellum more or less black or fuscous; mesothorax opaque, roughly, densely and confluent punctured, the scutellum very densely so; tegulae piceous; wings subhyaline, nervures black, second submarginal, half the length of first, receiving the first re-

pubescence; wings subhyaline, darker on apical margin, nervures fuscous, second submarginal cell obliquely quadrate, half the length of first, third submarginal truncate at tip, narrowed one-half towards marginal; legs with black pubescence, mixed with pale on femora and tibiae, that on tarsi beneath fulvous, posterior tibiae and tarsi fulvous clothed with long fulvous pubescence, tip of first joint black; abdomen shining, base of first segment clothed with pale ochraceous pubescence, a narrow band at base of segments 2 and 3, and broad band at apex of 4, of short dense appressed pale ochraceous pile; apex and venter with short black pubescence. Length .40 inch.

Hab. Porto Rico (Krug). One specimen. This may prove to be the ♀ of *mimica* Cress.

Heliodes albilabris.

♂.—Black; head and thorax clothed with a long, dense griseous pubescence, mixed with black on face, vertex and mesothorax anteriorly, and tinged with yellow on sides of scutellum and metathorax; labrum white; antennae three-fourths the length of the body, third joint a little longer than second, flagellum dull fulvous beneath; tegulae yellowish; wings tinged with yellow, apical margin dusky, nervures pale fuscous, second submarginal cell less than half the length of first, the third shorter than first and only slightly narrowed towards marginal; legs slender, clothed with pale pubescence, that on outside of posterior tibiae and tarsi black, tips of tarsi pale ferruginous; apical margin of abdominal segments above broadly pale testaceous, clothed with a very short dense appressed golden pile, base of first segment with a whitish pubescence. Length .40 inch.

Hab. Mexico (Sumichrast). One specimen.

Heliodes otomita.

♂.—Small, black; head and thorax clothed with a dense griseous pubescence, that on occiput, disk of mesothorax and scutellum more or less black; clypeus pale yellow; antennae as long as head and thorax, third joint about twice the length of second, flagellum beneath except first joint fulvous; tegulae piceous; wings hyaline, apical margin dusky, nervures pale fuscous, second submarginal large, about equal with first, third rounded at tip and narrowed one-half towards marginal; legs clothed with griseous pubescence; first segment of abdomen clothed with griseous pubescence, seg-

ments 2-5 covered more or less with a dense ochraceous pile, becoming more dense on the apical margin and forming golden-ochraceous bands; apical segments black, the sixth with a blunt tooth on each side. Length .35 inch.

Hab. Mexico (Sumichrast). One specimen.

Melissodes tepida.

♀.—Black; head, thorax, legs, and base of abdomen clothed with a dense pale ochraceous pubescence; mandibles yellowish toward tips; flagellum fulvo-testaceous beneath; posterior tibiae and tarsi clothed with a long dense pale ochraceous pubescence; wings subhyaline, nervures fuscous, second submarginal cell two-thirds the length of first, the third broadly rounded at tip and narrowed more than one-half towards marginal; segments 2-4 of abdomen covered almost entirely with a short dense pale appressed ochraceous pile; two apical segments black, a patch of pale pubescence on each side of the fifth; venter fringed with pale pubescence. Length .40 inch.

Hab. Nevada (H. Edwards). One specimen.

Melissodes ruavis.

♀.—Black; head, thorax, and base of abdomen clothed with a dense pale ochraceous pubescence; clypeus nearly nude, shining; mandibles near tips and flagellum beneath rufo-testaceous; tegulae pale fulvous; wings hyaline, nervures black, second submarginal cell half the length of first, the third truncate at tip and suddenly narrowed one-half towards marginal; legs clothed with pale pubescence, that on tibiae and tarsi fulvous, long and dense on posterior

genus antennae three-fourths the length of the body, third joint shorter than the second, flagellum pale fulvous beneath; wings hyaline, nervures pale fuscous, second submarginal cell half the length of first, the third rounded at tip and narrowed one-half to marginal; legs with griseous pubescence, tarsi pale ferruginous at tips, abdomen clothed with a griseous, sometimes brassy pubescence, long on basal segment, and forming a more or less indistinct band near apex of remaining segments; apical margin of the segments dull testaceous, sides of two apical segments with a short acute tooth. Length .35 inch.

Hab. California (H. Edwards). Six specimens.

Heliocheilus barwili.

♂ — Black, clothed with a dense white pubescence; clypeus, antennae, and spot at base of mandibles yellowish-white, antennae two-thirds the length of body, second and third joints subequal, legs brown fulvous, the base of joints above black, wings uniformly hyaline, nervures pale fulvous, second submarginal less than half the length of first, the third broadly rounded at tip, and narrowed one-half towards marginal, tips of tarsi pale ferruginous; apical margin of abdominal segments whitish and having a fascia of white pubescence, two apical segments each with a tooth at extreme sides, venter clothed with white pubescence. Length .07 inch.

Hab. Colorado (Prof. F. H. Snow). One specimen. This is larger than *adulæ* Cress, and with the abdomen distinctly fasciate.

Heliocheilus tepaneca.

♂ — Black, head clothed with whitish pubescence, that on labrum long and ochraceous, that on occiput fulvous with a line of long erect back hair behind the ocelli; thorax above clothed with a dense fulvous pubescence, that on the sides and beneath more sparse, legs pale fulvous; wings subhyaline, dusky at cost, nervures fuscous, second submarginal cell half the length of first, the third rounded at tip and narrowed one-half towards marginal; four anterior legs clothed with fuscous pubescence, all the femora whitish, that on posterior tibiae and tarsi more so, long, and dense; base of first segment and sides of ventral segments with long ochraceous pubescence, a narrow band at base of second segment, a narrow band across the middle, a broad band at base of third, and another at tip of fourth, all of dense

appressed ochraceous pile, that on fifth segment more or less interrupted on posterior middle; apical segment with black pubescence, mixed with ochraceous laterally. Length .45 inch.

♂.—The pubescence longer and more dense, and entirely fulvous or ochraceous except on apical segments of abdomen; clypeus, labrum, and spot on base of mandibles pale yellow; antennae three-fourths the length of abdomen, third joint a little larger than second, flagellum pale fulvous beneath; legs brownish, clothed with ochraceous pubescence, tarsi pale fulvous; abdomen marked as in ♀, with the pubescence on basal segment fulvous; two apical segments each with a short tooth on extreme sides. Length .40 inch.

Hab. Mexico (Sumichrast). Twelve specimens.

Mellocodes aurigena.

♀.—Black; head, legs, and basal segment of abdomen clothed with ochraceous pubescence, the thorax with dense fulvous pubescence, paler on the sides and beneath; flagellum fulvo-testaceous beneath; wings uniformly hyaline, nervures pale fulvous, second submarginal cell more than half the length of first, the third truncate at tip and narrowed one-half to marginal; posterior tibiae and tarsi with long fulvous pubescence, that on base of tarsi, at tip and within black; band at base of second abdominal segment, another on the middle, sometimes suffused with that at base, and a broad band at apex of segments 3 and 4, of dense appressed ochraceous

is impossible to accurately determine from his imperfect description.

Melissodes fulvohirta.

♂.—Black, clothed with a bright fulvo-ochraceous pubescence; clypeus and labrum yellow; antennæ a little longer than head and thorax, entirely black, subcrenulate at tip, third joint nearly three times the length of second; wings subhyaline, fuscous on apical margin, second submarginal cell large, two-thirds the length of first, the third truncate at tip and narrowed nearly one-half to marginal; tips of tarsi pale ferruginous; abdomen shining, the apical margin of the segments above and beneath rufo-testaceous, the second and following segments densely clothed with a short dense bright fulvous pubescence; venter piceous, apical margin of the segments fringed laterally with fulvous pubescence. Length .50 inch.

Hab. Georgia (Morrison). Two specimens.

Melissodes exquisita.

♀.—Black; head and thorax clothed with a dense pale ochraceous pubescence, whitish on cheeks and thorax beneath, and mixed with fuscous on occiput, mesothorax, and scutellum; mandibles yellowish before tips and fringed beneath with long pale hair; pubescence of mesothorax short and sparse on disk; wings fuscous, with a violaceous reflection, nervures black, second submarginal cell more than half the length of first, the third truncate at tip and suddenly narrowed one-half towards marginal; legs with fulvo-ochraceous pubescence, long and dense on posterior tibiae and tarsi, that on femora pale ochraceous; first segment of abdomen clothed with a long ochraceous pubescence, the remaining segments covered with a dense appressed golden-fulvous pubescence; ventral segments fringed at apex with a long dense fulvo-ochraceous pubescence. Length .60 inch.

Hab. Mexico (Sumichrast). One specimen. A very distinct and beautiful species.

Melissodes strenua.

♀.—Black; face and cheeks clothed with griseous pubescence, vertex, occiput, and thorax with dense fulvo-ochraceous pubescence; large, transverse mark on apex of clypeus, labrum, and spot on base of mandibles yellowish; flagellum fulvo-testaceous beneath; tegulae pale fulvous; wings fusco-hyaline, tinged with

yellowish, nervures fuscous, second submarginal cell more than half the length of first, the third subtruncate at tip and narrowed nearly one-half towards marginal; legs with fusco-ferruginous pubescence, paler on anterior pair; abdomen smooth and shining, very finely punctured, base and sides of first segment clothed with ochraceous pubescence, base and sides of second, sides of third and the fourth almost entirely covered with a very short dense appressed cinereous pile; two apical segments and venter clothed with a fulvous pubescence. Length .65 inch.

♂.—Very much like the ♀, but with narrower abdomen, clearer wings, and fulvo-ferruginous legs; clypeus except base, labrum, and spot on base of mandibles pale yellow; flagellum pale fulvous beneath; abdomen more or less incurved at tip, first segment except apex clothed with fulvous pubescence; base of second and a short line on each side near apex, base and apex of third and fourth, and the two following segments entirely, covered with a fine dense appressed ochraceous pile; sixth segment with a short tooth on each side; apical segment narrowed and truncate at tip. Length .60 inch.

Hab. Georgia, Texas, New Mexico. This fine species is allied to *pruinosa* Say, but is much larger, and the abdomen not so distinctly banded.

Melissodes australis.

♀.—Black, shining; head and thorax clothed with a short dense cinereous pubescence, that on thorax above tinged with ochraceous; clypeus, vertex, and disk of mesothorax smooth and nude; tergites fulvo-testaceous, venter blackish, faintly dusky on apical

♂.—The pubescence paler and more dense than ♀, especially on the abdomen which is narrower and more convex; tip of clypeus and vertex nude, smooth, and shining, labrum densely pubescent; antennae short as in ♀; four posterior legs robust, the femora and tibiae incrassate, the tarsi slender and fringed with long pale pubescence, basal joint of posterior tarsi long and curved, and having at apex beneath a prominent curved, subacute tooth, which is flattened and dilated at base; abdomen densely clothed with a short erect pubescence, generally cinereous, sometimes tinged with ochraceous, especially at tip, that on apical margin of the segments narrowly white; apical segment bidentate. Length .45-.50 inch.

Hab. Colorado (Ridings, Morrison); Texas (Belfrage). Eighteen specimens. This is closely allied to *enavata* Cress., which, however, has the pubescence darker, the wings more dusky and sabriolaceous at tips, and the second submarginal cell narrowed above. The ♂ closely resembles *ursina* Cress. (which is probably the ♂ of *enavata*), but is easily distinguished by the conspicuous toothed process at tip of basal joint of posterior tarsi, not seen in *ursina*.

This and the remaining species described under *Melissodes*, seem intermediate between that genus and *Anthophora*, the ♂ antennae, except in *pinguis*, being little or no longer than those of the ♀. The neuration of anterior wings resembles that of *Melissodes*, with the marginal cell long and pointed at tip, and not shortened and broadly rounded as in *Anthophora*.

Melissodes diminuta.

♀.—Small, black, clothed with a short dense ochraceo-cinereous pubescence, vertex and disk of thorax smooth and polished; antennae about as long as the head is broad, entirely black; tegulae fuscous; wings hyaline, nervures fuscous, second submarginal cell half the length of first, narrowed above, the third as long as first, rounded at tip and narrowed more than one-half towards marginal; four anterior tibiae and tarsi robust, tarsi long, slender, simple, the basal joint of posterior pair curved; abdomen densely pubescent, that on apical margin of segments paler, apical segment bispinose. Length .32 inch.

Hab. Colorado (Morrison). Two specimens. This is a miniature of *ursina*.

Melissodes olivacea.

♀.—Small, robust, black; head clothed with griseous pubescence, tinged with greenish-ochraceous on occiput; mandibles pale yellowish at base; flagellum fulvo-testaceous beneath; thorax clothed with a short dense pale ochraceous pubescence, tinged with greenish-yellow above, longer and pale beneath; tegulae fulvo-testaceous; wings subhyaline, tinged with yellowish, nervures fuscous, second submarginal cell more than half the length of first, narrowed above, the third longer than first, rounded at tip and narrowed nearly two thirds towards marginal; legs brown, clothed with pale ochraceous pubescence, long on posterior pair; abdomen broad ovate, depressed, clothed with a short dense appressed greenish-yellow pubescence, more dense on apical margin of the segments, that on base of first segment longer, pale and suberect, extreme apex of abdomen fuscous. Length .35 inch.

♂.—Form narrower, the pubescence more dense, especially on face and thorax above; clypeus and mandibles dull yellow; antennae short, but little longer than those of ♀; pubescence of thorax and abdomen brighter in color than in ♀; legs much paler, the two anterior pairs pale testaceous in front, anterior pair short, slender, fringed with long pale pubescence, the two posterior pairs long, subrobust, tarsi long, pale, fringed with long whitish pubescence, the basal joint long, slender, curved, clothed within with yellowish pubescence. Length .30 inch.

Hab. Mexico (Sumichrast). Twelve specimens.

Melissodes pinguis.

♂.—Form stout, robust, black, head thickly clothed with a short

pile; ventral segments fringed with fulvous pubescence. Length .35 inch.

♂.—Form narrower, more convex, the pubescence more dense; clypeus, labrum, and spot at base of mandibles yellowish-white; antennæ as long as head and thorax, the flagellum dull testaceous beneath; pubescence of thorax above longer; wings darker, the third submarginal narrowed nearly three-fourths towards marginal; legs slender, simple, clothed with griseous pubescence; base of abdomen with whitish pubescence, the two apical segments each with a short tooth on extreme sides. Length .30 inch.

Hab. Mexico (Sumichrast). Six specimens.

Melissodes afflicta.

♀.—Black, shining, clothed with a short griseous pubescence; clypeus, vertex, most of thorax above and scutellum nude, smooth, and shining; tegulæ pale brown; wings tinged with fuscous, nervures black or fuscous, second submarginal cell about half the length of first, narrowed above, the third subtruncate at tip and narrowed one-half towards marginal; legs with pale ochraceous pubescence, long on posterior pair, that at tip of posterior tibiæ and on tarsi fuscous or black; abdomen depressed, shining, first segment clothed with griseous pubescence, apical margin of segments 2-5 with a narrow band of dense appressed white pubescence, apex tinged with fuscous; ventral segments fringed at apex with fuscous pubescence, pale on the sides. Length .40 inch.

♂.—Much more densely pubescent than ♀, that on thorax above much darker; antennæ short as in ♀; posterior legs incrassate, the tarsi long, first joint curved, with the tip prolonged within; first and second segments of abdomen and venter clothed with a short dense griseous pubescence, that on the remaining segments black or fuscous, apical margin of segments 2-5 and sometimes 6, fringed with whitish pubescence; apical segment bidentate at tip. Length .30-.35 inch.

Hab. Texas (Belfrage, Heiligbrodt). Seven specimens.

Melissodes apache.

♀.—Black; head and thorax rather densely clothed with a griseous pubescence, more or less ochraceous or fulvo-ochraceous on thorax above; apex of clypeus, vertex, and disk of mesothorax smooth and shining; tegulæ pale piceous; wings hyaline, nervures fuscous, second submarginal cell about half the length of first,

nearly quadrate, very slightly narrowed above, the third larger than first, truncate at tip and narrowed one-half towards marginal; legs with ochraceous or pale ochraceous pubescence, long and dense on posterior pair, that on base of posterior tarsi within fuscous or black; abdomen covered with a short appressed whitish or cinereous pubescence, not entirely concealing the surface, that on extreme apical margin of the segments dense and forming narrow bands, apex of fifth segment and the sixth more or less fuscous. Length .30-.35 inch.

Hab. Texas, New Mexico, Arizona. Six specimens.

Melissodes Sumichrasti.

♀.—Black; head clothed with short cinereous pubescence, that on vertex and occiput longer and mixed with fuscous; thorax above with a short dense bright fulvo-ferruginous pubescence, that on the sides and beneath cinereous; tegulae fulvo-testaceous; wings subhyaline, tinged with yellow, nervures fuscous, second submarginal cell about half the length of first, subtriangular, being narrowed above, the third shorter than first and only slightly narrowed towards marginal; legs with pale pubescence, that on tarsi fuscous; abdomen with very short fuscous pubescence, that on first segment pale, segments 1-4 each with an apical band of dense appressed pale ochraceous pile; ventral segments fringed with pale pubescence. Length .35-.40 inch.

♂.—Pubescence of thorax much paler than on ♀; four posterior

and prolonged; abdomen shining, clothed with pale pubescence, that on middle of segments 3-6 mixed with fuscous, apical margin of 2-6 each with a narrow fascia of short dense white pubescence, sides of apex and venter with white pubescence, apex prominently bituberculate. Length .45-.50 inch.

Hab. California (Crotch). Three specimens.

Helimedes talus.

♀—Black; face and occiput clothed with ochraceous pubescence, sometimes more or less fulvous, that on cheeks whitish; mandibles with a white spot at base; thorax with a whitish pubescence behind, laterally, and beneath; mesothorax densely punctured, opaque, with a very short, sparse fuscous pubescence, longer and more dense on sides of scutellum; tegulae piceous; wings hyaline, nervures black, second submarginal cell about one-third the length of first, subtriangular, the third nearly as long as first, subtruncate at tip and narrowed one-half towards marginal; legs piceous or black, thinly clothed with pale pubescence, posterior tibiae and tarsi with a long, loose floccus of blackish-plumose pubescence, more or less mixed with cinereous beneath; abdomen shining, black, basal segment with a little pale pubescence at base, apical margin of segments 1-4 with a narrow fascia of white or yellowish-white pubescence, more or less interrupted on 1 and 2 apically. Length .28-.32 inch.

♂—Resembles the ♀, but with the pubescence of head and thorax more dense; mandibles with a white spot at base; legs with pale pubescence, posterior femora and tibiae very robust, outer side of their tibiae flat with a short tooth on inner margin towards the tip, and basal joint of their tarsi with a small tooth directed towards the base; abdomen with a narrow line of white pubescence at apex of all the segments except the last, which is pointed and whitish. Length .25 inch.

Hab. Mexico (Sumichrast). Six specimens. This is allied to *Helimedes* Smith, but is much smaller and otherwise very different.

Helimedes bombiformis.

♂—Black; head and thorax clothed with short ochraceous or fulvous pubescence, sparse on face; vertex shining; clypeus sparsely punctured, nude on the disk; pubescence of thorax very dense; tegulae fulvo-testaceous; wings fuscous, paler

on apical margin, nervures black, second submarginal cell about two-thirds the length of first, narrowed above, the third shorter than first, rounded at tip and narrowed nearly one-half towards marginal; legs piceous, the pubescence black, mixed with pale on anterior pair, that on posterior legs long; abdomen opaque, with very short black or fuscous pubescence, that on first segment sometimes mixed with ochraceous. Length .55-.70 inch.

♂.—Closely resembles the ♀; clypeus and labrum with short dense ochraceous pubescence; antennæ short as in ♀; legs robust, especially the posterior pair, the pubescence very short, black, ochraceous on coxæ, trochanters and anterior femora beneath, four posterior tarsi long, the basal joint of posterior pair long and curved; basal segment of abdomen clothed with short dense ochraceous pubescence, that on venter with black or fuscous. Length .60 inch.

Hab. Virginia, Georgia, Kansas. Six specimens. This has much the appearance of certain species of *Bombus*.

Tetralonia Gabbli.

♀.—Large, black, clothed with black pubescence, that on labrum fuscous; mandibles with a yellowish line; wings fusco-hyaline, darker at base, nervures black; pubescence of legs entirely black; abdomen above except first segment covered with a short very dense ochraceous pubescence, that on first segment long and black. Length .85 inch.

♂.—Clypeus and base of mandibles yellow; antennæ short as in ♀; apical segment of abdomen flattened and quadrate above, the sides concave and the apical margin truncate. Venter smooth

Megacilissa mexicana.

♀.—Black; head clothed with a griseous pubescence, that on face and vertex intermixed with fuscous; flagellum dull testaceous beneath; thorax above clothed with a short dense fulvous pubescence, that on the sides and beneath pale ochraceous intermixed with fuscous; tegulæ pale fulvous; wings yellowish hyaline, dusky on apical margin, second submarginal cell small, narrow, nearly pointed towards marginal; legs clothed with fuscous pubescence, that on posterior femora and tibiæ beneath dense and ochraceous, basal joint of posterior tarsi short and broad; abdomen with a greenish-blue reflection, strongly pale sericeous, first segment clothed with a short fulvous pubescence, that on extreme sides of remaining segments long and golden-ochraceous, that on the two apical segments long and fuscous, intermixed with ochraceous; venter piceous, fulvo-testaceous at base of the segments, which are fringed at apex with a long pale fulvous pubescence. Length .75 inch.

Hab. Mexico (Sumichrast). One specimen.

Megacilissa electa.

♂.—Black; head and thorax clothed with a short dense fulvous pubescence, paler laterally and beneath; wings pale yellowish hyaline, dusky on apical margin, second submarginal cell about one-third the length of first and narrowed nearly one-half towards the marginal; legs long and slender, clothed with ochraceous pubescence, tibiæ and tarsi pale fulvous; abdomen clothed with a short black pubescence, longer on apical segments, that on first segment above and two basal segments beneath, ochraceous, extreme sides of second dorsal segment fringed with pale ochraceous pubescence. Length .75 inch.

Hab. Georgia (Morrison). One specimen.

MAY 21.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-seven persons present.

Knee-joint of the Kangaroo.—Dr. A. J. PARKER remarked that in studying the anatomy of various animals, but little attention has been given to the comparative structure of the articulations. One reason for this is, that fulfilling as they do mechanical functions almost similar in different animals, their structure varies but little. In examining the knee-joint of the kangaroo, however, an arrangement of ligaments was met with so different from what is ordinarily found in this joint that it deserves some attention. In man the knee-joint is the most complex of all the articulations, and in the kangaroo it is even more complex than in man. This is in accordance with the increased functional use of the joint in this animal. In making its immense leaps, the knee-joint becomes the centre on which the greater part of the strain is exerted and it requires a corresponding strength of structure. This increase in strength and stability is secured by a peculiar arrangement of the ligaments corresponding to the crucial ligaments of man. These ligaments are three in number and are arranged in a very interesting and complex manner. The posterior horn of the external semilunar fibro-cartilage is free and runs continuously into the fibrous tissue of a crucial ligament which proceeds forwards and inwards, and is inserted into the inter-condyloid fossa. The ligament being thus free at its posterior portion would tend to ride upwards, but this is prevented by a stay ligament which runs from about the middle point of this crucial ligament posteriorly, and is inserted into the posterior part of the space of the condyloid fossa.

the joint a very interesting and peculiar mechanical structure. There are no ligamenta alaria or mucosa.

MAY 28.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-three persons present.

On Polyxenes fasciculatus.—Mr. J. A. RYDER announced that he had identified the myriapod *Polyxenes fasciculatus*, Say, in the vicinity of the city at several places in the park. It was found that its morphological history agreed with that of *P. lagurus*, of Europe, as detailed by Bode,¹ but there was the same paucity of males as observed by that naturalist. The presence of the hooks terminating the caudal bristles was an independent discovery so far as the American species was concerned, Mr. Ryder not having seen Bode's paper until three days after his own observations had been made. Upon comparing these parts of the two species together we find the ends of the bristles, according to Bode, in the European species bent in the form of a semicircle, with the subterminal processes depending parallel to each other from within the arc; in our species, on the other hand, the bristle terminates in two barbed diverging points directed forwards, forming a subacute angle with the supporting shaft of the bristle, the subterminal processes depending within the angle on the supporting shaft next the animal. This new locality indicates a wide distribution for the animal, viz., from Georgia, where it was first discovered by Say, to Massachusetts, where it has been found by Packard.

Corundum in North Carolina.—JOSEPH WILCOX said that he desired to place on record a locality for Corundum recently discovered in Iredell Co., North Carolina. Near Statesville, as the northern limit, it is found associated with Kyanite and Serpentine. It is also found at several localities for a distance of twenty miles east-northeast of Statesville, and at its northern limit it is associated with Steatite, Actinolite, and Damourite. No large specimens of Corundum have yet been found at this locality.

Prof. Gemesindo Mendoza, of Mexico, and Stephen Bowers of Santa Barbara, Cal., were elected Correspondents.

The following paper was ordered to be printed:—

Zetsch. f. die gesammten Naturwissenschaften. 3te folge, Berlin, 1877.
34 H., 8vo. pp. 233-268, Pl. 11-14.

**TRANSITION FORMS IN CRINOIDS, AND DESCRIPTION OF
FIVE NEW SPECIES.**

BY CHARLES WACHSMUTH AND FRANK SPRINGER.

The subcarboniferous rocks of the Mississippi Valley have been divided, by geologists generally, into five divisions or groups, viz., the Kinderhook, Burlington, Keokuk, St. Louis, and Chester, which occur in the order named; the Kinderhook being the lowest and oldest. Full accounts of these formations may be found in the Reports of the Geological Surveys of Iowa and Illinois, to which we refer for detailed information. Of these groups, the Burlington and Keokuk limestones, extending in vertical range from the Oolite bed, which forms the summit of the Kinderhook, into the Geode bed, which apparently forms the boundary between the Keokuk and St. Louis limestones, are characterized in their fossil remains by a great predominance of crinoids. They are thereby somewhat conspicuously distinguished from the other members of the subcarboniferous series. It is to these crinoidal beds that our observations are at present limited. Their fossiliferous character is well known, and we may add that there is probably no region in the world which exhibits, within the same limited geographical extent, so great and uninterrupted a range of crinoidal deposits in geological succession, almost unaltered by disturbing forces, and which at the same time affords such a variety and abundance of well preserved specimens for accurate comparative study, as

eous beds, above which appeared the Keokuk limestone, differing from the Burlington beds in the specific characters of its fossils, as well as in lithological characters; that the three formations presented in their crinoidal remains three successive grades of development, those of the lower bed being generally of small size and delicacy of construction and ornament, those of the upper bed being of stronger construction and ruder form, while in the Keokuk they reach a culmination of rudeness and extravagance of form and size. He states that few, if any, species of these fossils are common to both beds of the Burlington limestone, and that it is hardly probable that any will be found common to the Burlington and Keokuk. The same writer, in the *Geology of Iowa*, 1870, vol. I. p. 202, says that the separation of the formations of the subcarboniferous group from each other is abrupt and distinctly defined; that the interposition of silicious beds constitutes paleontological boundaries between them; and that the change in the lithological character of each deposit toward the close of each epoch, seems to have had the effect to check, and finally to arrest the progress of those forms of life which previously existed in great profusion; and that with the resumption of calcareous deposits in the succeeding epoch, similar, if not identical forms, were introduced, which flourished and progressed until arrested again by similar deposits of silicious strata. And on page 203, speaking of the two divisions of the Burlington limestone, he says, "It seems that the accession of silicious material to the waters of that epoch resulted in, or at least was followed by, the extermination of all the species of crinoids then existing, and although they flourished in just as great profusion when the calcareous condition of the waters was restored, they were all of new species, these being all in turn exterminated by the accession of silicious material which we find to mark the close of the full epoch of the Burlington limestone."

Such may be taken as the prevalent opinion among geologists and paleontologists as to the faunal independence of these three formations, although Dr. White does not deem it expedient to recognize two distinct formations in the Burlington beds, as proposed by Niles and Wachsmuth in *Amer. Journ. Science*, July, 1866, and as in practice is done by all the later paleontologists and collectors, it being shown by experience that in their organic remains, particularly crinoidal, the distinction between the two

Burlington beds is much more sharply marked and clearly defined than between the upper bed and the Keokuk limestone. The geologic independence of the two latter beds has been scrupulously regarded by paleontologists, and in no case within our knowledge has a single species of crinoid, out of the many hundreds described, been noted as occurring in both formations. Indeed, it would seem, judging from the descriptions, that the increase in new species would serve to confirm their separation. But an observer who is familiar with the stratigraphy, as well as the fauna of these rocks, throughout their whole vertical range, obtains an entirely different impression. Of the many distinguished paleontologists whose labors have contributed to our knowledge of the fauna of these beds, the majority were not themselves collectors, and they were therefore destitute of that personal familiarity with the mode of occurrence of these fossils, which is so important an aid to an accurate understanding of their relations. The material on which new species have been described has often been comparatively limited, and specific characters were readily distinguished in a single specimen which could not have been defined in a large series. There has also been some confusion, we believe, in regard to the actual horizon of the types of new species collected by various parties along the border land between the Burlington and Keokuk, some localities being referred to the one or the other, when in fact they belonged exclusively to

great abundance into the waters was largely destructive of crinoidal life, and had also an important influence in producing the changes observed in the crinoids of the successive deposits. It seems, indeed, when there was too much of it, growth was arrested and life destroyed; but when it existed in the waters in moderate proportion, along with calcareous constituents, its presence was favorable to existence and individual growth. It is on the upper surface of cherty layers in the Burlington and Keokuk beds, that we find most of the "colonies" or local deposits of well-preserved specimens, and from the upper beds to and including the Keokuk, there is more or less of silicious matter in the matrix and in the fossils themselves. The strata which compose the beds of passage between the three beds are mostly impure cherty limestone, in which the proportions of silicious and calcareous constituents vary, and it is a fact that throughout these deposits, wherever a little bed of limestone appears, or the chert becomes rather calcareous in its composition, we find the remains of abundant crinoidal life, although mostly in imperfect preservation.

It thus seems that, notwithstanding the destruction caused by the silicious influx, some of the crinoids survived here and there, and struggled through until more favorable conditions again prevailed. In proof of this, we have the fact that throughout the cherty deposits between the Upper and Lower Burlington beds, we find more or less the remains of crinoids, usually in the form of casts and very imperfect, yet sufficiently distinct to be recognized as *Actinocrinus*, *Platycrinus*, etc. But it is in the beds of passage between the Burlington and Keokuk that we find the most satisfactory evidence of the persistence of crinoidal types, and these with the crinoids found therein form the basis of this paper.

The close of the Upper Burlington limestone (as heretofore considered) was marked by an extraordinary destruction of fishes, whose remains, in the form of teeth and spines, are found in the greatest profusion in a stratum two to ten inches in thickness, which occurs at the very top of the regular limestone beds. It is one of the best stratigraphic landmarks that we know in this formation, as it is found over a wide area in localities over a hundred miles apart, and always in the same position relative to the heavy limestone beds. It is succeeded immediately by cherty layers, sometimes in regular bands and sometimes in irregular

masses, with the interstices filled with a fine, brownish-red, silicious clay. These layers average about six to eight feet in total thickness, and above them there appears a stratum of whitish-gray crystalline limestone, from one to two feet thick, on the upper surface of which, and only on the surface, so far as observed, is found another deposit of fish remains. This is succeeded by two or three thinner layers of similar texture, separated by silicious shales and yellowish sand, and above these occur other irregular beds of argillaceous and cherty limestones of varying thickness, which pass gradually and imperceptibly into the bluish-gray limestones of the Keokuk proper. These deposits, from the first fish bed up to the Keokuk limestone, we designate, simply to save repeated explanations, as the "transition beds." They are found well exposed near Burlington, and at Augusta and Pleasant Grove, Iowa, both within twenty miles of Burlington, and at Sagetown and Nauvoo, Illinois, at all of which localities we have carefully studied them. At Nauvoo they are much thickened, and are seen above the town from the water's edge well up into the bluffs, which are capped by the Keokuk limestone, while in the extensive quarries below the town, only the Keokuk limestone has been exposed. A want of attention to these facts has caused some confusion as to the true horizon of the species described from that locality, all being referred to the Keokuk, whereas we have found at the upper locality true Burlington species, such as *Granatocrinus Sayi* and other well-marked species. The transition beds are more or less fossiliferous throughout, though the occurrence of the fossils is irregular and their preserva-

appropriately be called the "crinoidal limestone." A considerable number of the fossils, under consideration herein, were obtained from a single layer of limited extent in the fish bed at the top of the Upper Burlington limestone. They are of comparatively few species, and those are extremely rare in other localities, but at this spot they seem to have flourished in extraordinary abundance. These specimens form so important a part of our material that, to avoid repeated allusions to the locality, we refer to them always as the "fish-bed fossils."

In the following pages we shall endeavor to illustrate in detail, with the excellent material at our command, largely collected with special reference to this subject, the transition between the forms of crinoids in the Upper Burlington and Keokuk beds, which we believe will possess geological as well as zoölogical interest.

It is to be regretted that greater attention has not been hitherto paid to the individual growth of crinoids. We have made collections expressly for the purpose of illustrating different stages of development, and have found it to be the rule, that in young crinoids, the basals are the most perfectly developed parts. They attain nearly their full size in young individuals, greater in proportion than the subradials and radials, which are comparatively early developed, and at a time when the interrarial and anal plates have scarcely made their appearance. The latter develop the slowest, and in some genera increase continually both in size and number during the growth of the individual. We also find that external growths, or sudden modifications of specific characters, almost always take place in the interrarial and anal areas, the posterior rays, and consequently in the dome. Species have been multiplied by attaching too much importance to characters based on such modifications as the comparative size of the base, the number of interrarial and anal plates, a more or less elongate form, etc., which we believe are due in many cases to individual growth, and which in species, when found in a later geological period, form mere variations of the same species, as will be proved conclusively by the following genera.

1. **BATOCRINUS**, Casseday.

This genus is separated by Meek and Worthen into two sections, Ill. Geol. Rept., vol. V, p. 364, to which we refer for a full discussion of the generic characters and relations. In the first

section, *B. Christyi* is included, while *B. pyriformis* falls under the second. The two species form the types of two little groups of crinoids, which exhibit some very interesting features in connection with the succession of the crinoidal beds; both are very common and characteristic species of the Upper Burlington, and were described by Shumard in vol. II, Geol. Surv. Mo., with good figures, and figures of more perfect specimens are given in vol. V, Ills. Geol. Rept. Pl. V. There is a general difference in form and outline between the two species, but their chief distinction, and the one which produces apparently all the other constant differences, is that *B. pyriformis* has 20 arms, one from each opening; while *B. Christyi* has two arms to each arm opening, or 40 in all. This feature of *B. Christyi* has been for some time known, but hitherto the anatomical construction which produces it has not been understood, and this we are now enabled to explain. *B. Christyi*, in its typical form, has in each ray 3 primary, 2 secondary, and 2 tertiary radials, or radials of the third order, or as they are more commonly designated "brachials." The latter term is used for that series of radial plates within the body walls, which leads to an arm opening. The upper margin of the second or last of these brachial plates, is somewhat excavated, and in the rear of this cavity, the arm opening breaks through. In very well preserved specimens, when the arms have been removed, there may be seen upon the floor of this excavated margin, a narrow indented scar, extending from the arm opening directly outward. We have found resting upon this scar a very small, narrow, triangular or pentagonal plate, often, when the arms are



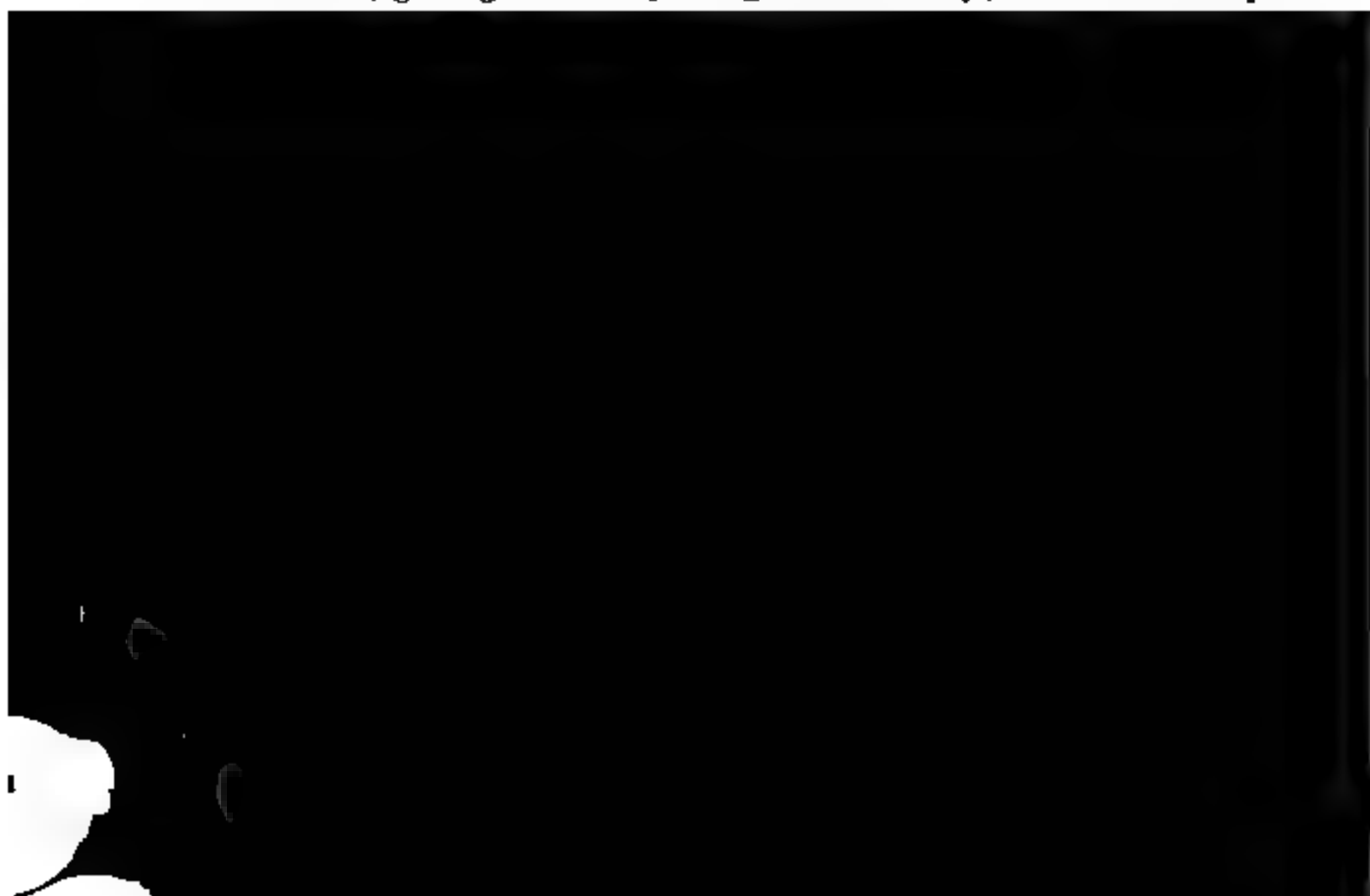
low convex to high conical, sharp and projecting over the upper edge of the disk. This row of projecting dome plates is a very characteristic feature of this species, but is entirely wanting in *B. pyriformis*, its absence giving to the dome in that species its pyriform aspect and the upward tendency of the arm openings; while in *B. Christyi*, it gives to the arm openings a lateral direction, and to the disk its wheel-like appearance with its wide periphery standing about parallel to the vertical axis. Its peculiar office is well shown in one specimen, which has abnormally two extra brachial plates, and two arm openings instead of one in part of the ray. Here, a single interbrachial dome plate is situated between the arm openings instead of one over each, and the construction below leaves no doubt, that from these two openings single instead of double arms proceeded.

B. Christyi is described as having 7 anals and 4 interradians in 3 ranges each, and radials $3 \times 2 \times 2$. Another species described by Meek and Worthen in vol. V, Ill. Geol. Rept. p. 372, under the name of *B. trochiscus*, belongs to this group, but has a more spreading disk, a more concave dome and a comparatively lower body than *B. Christyi*: it is described as having 12 anals and 6 interradians in 4 ranges each; radials $3 \times 2 \times 2$ with an extra anal of the third order (or brachial plate) in some parts of the rays, and 1 or 2 interaxillary or intersupraradial pieces. The second radial of the third order is long, bent upward, and about the arm opening constructed exactly as in *B. Christyi*. The same interbrachial dome plate is found over each opening, very sharp and prominent, and although *B. trochiscus* has never been found with any portion of the arms attached, we feel entirely certain that when discovered, they will be found to be double from their origin.

Leptæmus planodiscus, Hall (sp.), (Supplem. to Iowa Rept. p. 46) is of the same type, and has a form similar to *B. trochiscus* but with a much greater expansion of the disk, caused by an enormous development of the higher radial and interradian series. It has, according to diagram, 3 radials of the first order, 2 or 3 of the second, 2 or 3 of the third, and 1 or 2 of the fourth, or brachial pieces; 15 interradians in 9 ranges; 9 to 11 intersupraradials, 5 or 6 interaxillary plates between the series of radials of the third order, and it has 40 arm openings. The addition to the structure of *B. trochiscus* of another series of radials within the body walls,

and interaxillary plates between them, causes the arms, which, in that species, divided at the opening, to separate in *B. planodiscus* within the body, and to emerge simple from their origin. *B. Christyi* ranges through the Upper Burlington into the division beds. *B. trochiscus* is found only in the transition bed, while *B. planodiscus* is said to be from the Keokuk, although the type specimen came from Nauvoo, and there is the usual uncertainty in regard to its real horizon.

Now we have before us about 50 good specimens of *B. Christyi* from the Upper Burlington of various localities, all of which, by their peculiar aspect, are readily referred to this species. We find in them a wide variation in form, some being tall, with dome much elevated and rising uniformly from the margin of the brachial disk to the subcentral proboscis, others nearly turbinate below, with almost no expansion of the disk, and others having a low, broadly, and rapidly spreading calyx, with concave sides and a nearly flat summit. The proboscis is in small specimens, so far as observed, smooth, while in larger ones, it is rough, nodose, and spiniferous, the latter being generally the case in those found high up in the rock. Between these extremes there is every gradation. In these specimens, we find the following variations in body-structure: Anals, 5, 6, 7, 8, 9, 10, 11, and 21, in 3, 4, 5, and 6 ranges; inter-radials, 2, 3, 4, 5, and 6, in 2, 3, and 4 ranges, with variations of 2, 3, and 4 in different parts of the same individual. The radial series is $3 \times 2 \times 2$, except in one specimen (the one with 11 anals), which, on the inner branch of one posterior ray, has an additional bifurcation, giving 5 arm openings to that ray, or 21 to the speci-



of the third order, producing an expansion of the disk; and in one of them (evidently very mature), the interradial areas are much depressed, and the radial series elevated and rounded, giving to the calyx, as seen from below, a ten-rayed appearance. The proboscis, in specimens from the transition bed, is greatly developed, being very long, and its plates spiniferous.

We have never seen a specimen of *B. planodiscus*, but from the description and diagram, it is evident that this species has the same fundamental construction as the two preceding ones. The only important difference to be found is, in the additional bifurcation of the radial series within the body, and as a consequence of this structure, in the double number of arm openings. *B. Christyi* and *B. trochiscus*, though having 40 arms also, have but 20 arm openings, and the arms really branch after emerging from the body. In them, the small bifurcating plate which we have described, and upon which the arms divide, is evidently a rudimentary free radial, and the two plates beside it, which in *B. Christyi* were only arm plates, become developed in *B. planodiscus* into true radials and form a part of the body. That this is not a mere conjecture on our part is demonstrated by the individual growth of the disk generally. The young *Strotocrinus* for instance, though having the same number of arms as the adult, has but 4 arm openings to each ray. The radials of the higher orders, which in older specimens form a part of the body walls, are here still free plates, unsupported by any interradial or interaxillary pieces, which separately fill the spaces between them; but the number of arm openings of the nascent erinoid increases to the full number of rays in proportion to the increase of the upward growth of the body. This is exactly the case in *B. planodiscus*, and it will thus be seen that *B. Christyi* and *B. trochiscus* represent earlier stages of development, and that, as we have seen before, the two later forms differ from the older by those characters which appeared originally in *B. Christyi*, and became more fixed and general in the succeeding types.

B. pariformis, whose most important distinction from *B. trochiscus* has been mentioned, is described with 7 or 8 anals in 4 ranges, 5 or 6 interradials in 3 or 4 ranges; radials, 3 + 2 + 1 (see vol. V, Ill. Geol. Rept. p. 375, where Meek and Worthen give a detailed description). It ranges through the Upper Burlington

into the transition beds, where the *B. Nashvillæ* form predominates.

B. Nashvillæ, Troost, from the Keokuk limestone, is of the same type, but is larger, and its body and dome plates are more nodose, the interrarial areas constricted, so that the body is divided into lobes. It is described by Hall in vol. I, pt. ii, Iowa Geol. Rept. p. 609, with 8 or 9 anals, 5 to 10 interradians, and an intersupraradial plate between the radials of the second order in every ray; radials, $3 \times 2 \times 1$; arms, 20.

B. Nashvillæ var. *subtractus*, White, was described (Proceed. Bost. Soc. Nat. Hist. 1862, p. 16) as agreeing with the last species, except that it generally lacked the intersupraradial plate, this being found in one ray only. It was said to occur in the Upper Burlington.

In upwards of 40 good specimens of *B. pyriformis* examined, we find a great variety in form. In some, the body expands gradually and uniformly from the base to the arm bases, giving a turbinated outline below; while in others, it remains of nearly uniform size to the top of the second radials, when it suddenly and rapidly expands; the radials of the second order and brachials being in a plane nearly at right angles to the vertical axis. In some specimens, two-thirds of the body is below the arm bases, and in others, scarcely one-third. In some, the brachial disk is continuous; in others, the interrarial areas are somewhat be-

2, 4, and 5 ranges with variations in the same individual. As to the intersupraradials, upon which White founded his variety, we find in some specimens none, and in others one in 1, 3, 4, and even 5 rays respectively, while all our Keokuk species of *B. Nashville* proper, have an intersupraradial in every ray. But the presence and constancy of those plates, is evidently a natural consequence of the greater size of the Keokuk form, and hence of no specific value.

In *B. pyriformis*, the proboscis is long, rather strong, with moderately convex plates. In the *B. Nashville* from transition to it, the dome is prolonged into a proboscis over five times the height of the calyx, the plates of which are convex to slightly concave. In the *B. Nashville* of Keokuk, the proboscis is sharply elongated, but stronger, composed of very nodose plates, and about midway to its summit it is encircled by a row of five very strong spines, nearly an inch long.

We find that the modifications, thus observed in the successive forms of these two types, as they appear in the rocks, have taken place in exactly those parts of the crinoid which are changed by growth: that the prevailing features of the later species are those which in the Burlington types were irregularly developed during the life of the individual; and that the order in which these modifications appeared, corresponds very closely with the succession of changes from youth to maturity.

2. ERETMOCRINUS.

Lyons and Casseday, Am. Journ. Sci. 1859, proposed the above name for a type of Crinoids, principally distinguished by flattening of the arms in their upper parts. Meek and Worthen, Ill. Geol. Rept. vol. V, p. 367, placed it under *Batocrinus* as a subgenus, and made interesting observations on the genus and its associate forms. We have never seen a specimen of Lyons and Casseday's typical species, and are unable to undertake a discussion of these somewhat complicated generic relations. We are inclined to the opinion, however, that at present the characters of *Batocrinus* and *Eretmocrinus*, are not so clearly defined as could be desired. Under existing circumstances, we prefer to leave *Eretmocrinus* where its authors placed it. Among the fish-bed fossils, some of the most striking examples belong to this type. They exhibit the peculiar arm structure in

a remarkable degree, while they possess a special interest in connection with similar forms from other localities. The specimens here occurring belong to a single type. They are characterized by a low, broadly calyculate body, with basal plates in some cases, thickened into a slight rim at the margin, and in others projecting far out around the column in a tripartite disk. Three brachial plates, in succession, rest above the secondary (or supra) radials, with an extra set of radials of the third order, in part of those rays which have five arms. Dome much elevated, pyriform or hemispheric; its plates strongly nodose or subspiniferous. The surface of the body below the arms is ornamented by rugose ridges, which extend along the middle of the radial plates, and follow the branches to the arm bases, the latter being separated from each other by indented sutures. These ridges are in some specimens low and obscure; prominent and angular in others. The arms are strong, rather narrow as if laterally compressed, and nearly angular on the outside for about one-fourth their length. They are there very suddenly flattened, spread out laterally, and become broad and spatulate, remaining thick and heavy in the middle, and growing thin toward the edges. Their breadth at the widest point is about half an inch on an average, they taper very gradually toward the tips, the length being, in mature specimens, about four inches. They are composed of a double series of interlocking joints, which are very short in the lower, and longer in

testud arms, not only join with each other at the middle by interlocking angles, but have similar angles at their thin, lateral edges, which exactly correspond with the angles in the margins of the adjoining arms. Thus the edges of the arms could be united by closely fitting sutures into a continuous and impenetrable wall, and form an arched dome over the space above the arm bases. Indeed, we always find the arms folded inward at their extremities, no matter in what shape the specimens are crushed.

We have, from other localities in the Upper Burlington limestone, specimens which are perfectly smooth below the arm bases, but which in size, shape, and structure of the arms, agree with the fish-bed specimens very closely. Among a good number of the latter, we find some with 20 arms, some with 21, and some with 22, the difference being always in the posterior rays, as the others have uniformly 4 arms each. The variation in the surface markings bears no relation to that in the number of arms, for we find the smooth specimens with 20 and 21 arms, and the ornamental ones with 20, 21, and 22, and we are therefore led to believe that all the specimens under consideration belong to a single species.

Mex. and Worthen, in vol. V, Ill. Geol. Rept. pl. x. Fig. 5, give a figure of a specimen which was obtained at the same locality, though not in immediate association with our present collection of fish-bed fossils. It gives a good idea of the form under consideration, except that in perfect specimens, the flat-portion of the arms is at least twice as long as seen in the figure. It has three brachial plates in the body, and twenty arms. But that specimen, like those before us, clearly does not belong to *E. remibrachiatus*, described by Hall in his Preliminary Notes, 1841, p. 11, under *Actinocrinus*. His species had, according to the description, no body plates above the secondary squararadials, and had 16 arms which were rounded below and expanded above the middle, which is a totally different thing from our forms. We have not been able to exactly identify Hall's species, but we have several specimens of a form with but two squararadials in some parts of the rays, and a brachial plate in others. It has 14 arms which are very strong, rounded below and flattened above, and we think it belongs to *E. remibrachiatus*,

the type of which may have had, abnormally, an additional arm in each posterior ray.

Hall described and figured in the Iowa Rept. pt. ii. p. 615, pl. xv. Fig. 7, under the name *Actinocrinus ramulosus*, a specimen which in most respects shows a very near approach to the fish-bed forms. It is referred to the Keokuk limestone, but as it came from Nauvoo, we are left in doubt as to its actual horizon. It may have come from the transition beds, for we have from corresponding high beds at Augusta, Iowa, where these beds are extensively exposed, a specimen which seems to be almost an exact duplicate of Hall's type as figured. The ridges are composed of series of prominent tubercles in the centre of each plate in the radial and brachial series, and there are also, between the ridges, much smaller tubercles distributed around the margin of the anal and interradial plates. It has, moreover, 5 arms in each posterior ray, or 22 in all, and we have no doubt but that Hall's specimen would have shown the same number, if that portion of the fossil had been preserved. The arms are unknown. A comparison of our specimen of *A. ramulosus*, with the fish-bed forms of *Eretmocrinus* shows that they are most intimately related. The only difference, we can perceive, is the rather greater size and more elaborate ornamentation of the *A. ramulosus*, being difference in degree only, and not in kind.

We are thus brought to the conclusion that the type we have

3. AGARICOCRINUS, Troost.

On bringing together a large number of good specimens of *Agaricocrinus* from the Upper Burlington, transition and Keokuk beds from various localities, apparently belonging to several species, we found a satisfactory separation into species according to the descriptions impossible. We therefore thought to ascertain their relations by a comparison of the specimens before us, without regard to specific names or geological horizon. The comparative simplicity of construction and absence of ornamentation in this genus renders such an investigation more easy than in many other groups. To this end, we noted for each specimen, separately, the characters which in the descriptions have heretofore been considered of specific importance, viz., the form of the dome, of the basal concavity, and of the anal area; the shape and position of the second and third radial plates; the form and proportions of the interradians, and the character of the interradian area in the dome, the number of arms; and in addition to these, and not heretofore specially noted, the disposition of the apical plates of the dome. Tabulating these data independently of the specimens, we found that they fell naturally into two groups. The first of these is characterized by having the apical plates of the dome separated from each other by small intercalated plates; the central apical plate being tuberculiform and very much larger than its associates or any of the dome plates; the dome pyramidal, anal area flat, and the opening lateral; three arms to each posterior ray; second radial higher than wide; first interradian short, basal concavity small, involving the lower part of the third radial, which is convex. The second group is distinguished by having the apical dome plates connected except at the anal side, the central apical plate not greatly conspicuous above the others; the dome hemispherical; the anal area elevated, rounded, or protuberant, with the opening directed upward; the second radials nearly always subtriangular and wider than high. Within this group are forms with 2 arms to each ray, with 3 in one posterior ray, with 3 in one posterior ray, with 3 in one posterior ray and 4 in the other, with 4 in each posterior ray, the other rays in all cases, save one, being 2, with long and narrow first interradians, and with short basal concavities; with basal concavity very shallow, not involving any part of the third radials, and deep, entirely including them.

The first of these groups is sharply characterized, and is the well-known species *A. Wortheni*, Hall. The second is of the type *A. Americanus*, Roemer, but includes the features of *A. bullatus* and *A. excavatus*, Hall, and *A. nodosus*, M. and W., and a new form not heretofore noticed, having four arms in each posterior ray; but the combination of these characters was so perplexing that the identification of the species was wholly unsatisfactory. Upon arranging the specimens, however, according to the most general modifications, such as the greater or less elevation of the anal area and the number of arms, we found that they arranged themselves into a series, in which, while varying irregularly in the minor characters observed, the forms shaded gradually from one into the others, beginning with those having two arms to the ray and greatly protruding anal area, and ending in those with four arms to each posterior ray and a wide flat anal area. In these respects the succession was nearly regular, but no other characters were coincident with them, and, in other respects, there was no uniformity or constancy whatever. It was now found that the specimens had also arranged themselves according to their geological horizons, beginning with two-armed forms in the Upper Burlington, and extending regularly through the transition beds with two and three arms, to the four-armed forms in the highest part of the Keokuk.

In this study which we have described thus in detail, to show that there is nothing arbitrary or theoretical in the result announced, we used about thirty well-preserved specimens, besides the descriptions of the types, and we were forced to the conclusion



to think it probable that this form will be found with four arms to all the rays.

The Burlington species of *Agaricocrinus* are comparatively small, increasing in size in the upper bed; the transition bed fossils are larger still, and in the Keokuk there are found those ponderous, huge forms which are so characteristic of that horizon, and of which *A. Wortheni* is the extreme. With these extravagant forms the genus becomes extinct, and we meet it no more above the Keokuk beds.

4. ACTINOCRINUS.

The *lobed* Actinocrinus which Meek and Worthen considered to be the true type of the genus, is numerous represented in the crinoidal limestones, and a large number of species have been described from the Upper Burlington and Keokuk beds. The type of the genus is a form subglobose to turbinate below the brachial plane, very slightly convex to pyramidal above the arms, the interrarial spaces contracted, the radial areas prolonged and extended outward about at right angles to the vertical axis, and formed into lobes which increase in width as they recede from the body; thus giving to the fossil when seen from above or below, a pentapetalous aspect.

Its leading species in the Upper Burlington beds are *A. multiradiatus*, Shum. and *A. verrucosus*, Hall, both figured on Plate 10 of the Iowa Geol. Rept. The former is characterized by a very low, flat dome, with the interrarial areas greatly constricted and excavated; the latter by an elevated dome and a greater development of the interrarial dome plates, which extend down between the lobes and form a low rim connecting them. The former has 30 arms, the latter 40, the arms of both remaining simple throughout. In this genus, unless the arms themselves are preserved, it is very difficult to tell their number, for the long projecting lobes are almost always broken away with the arms. In large collections from the Burlington limestone, of specimens otherwise well preserved, it is exceedingly rare to find one in which the brachial plates are preserved to the bases of all the arms. They are generally broken away just above the first bifurcation in the ray, and the number of arms appears less than it really is. This was the case with *A. multiradiatus*, which is represented in the Iowa Report as having two arms to the ray; when in fact it has six as

large collections prove. In the Keokuk beds the genus attains its greatest development in size and extravagance in features. It is represented by a large number of described species, of which the leading types are *A. Lowe*i, *A. pernodosus*, and *A. jugosus*, Hall, and the species of *A. Humboldti* and *A. Agassizi*, Troost. Most of the Keokuk species were apparently described from specimens more or less imperfect in the brachial part of the lobes, so that very little reliance can be placed in the arm formulæ stated, and no information is given in the descriptions as to the nature of the arms in the different species.

The Burlington specimens exhibit much variation in proportions and ornamentation, and while they are generally of small size and neat sculpturing, we find occasionally a mature individual which, with most of the features of its associates, is much larger in size and is marked with that roughness of habit and rudeness of form, so prevalent in the Keokuk. The Keokuk species named are all very large, uncouth forms, with extreme rugosity of surface, the latter reaches its extreme in *A. Agassizi* and *A. pernodosus*, while in *A. Lowe*i, the contraction of the interrarial spaces above the arm bases is so great, that almost the entire dome is included in the five lobes. Specimens from this formation, preserving the arms, are exceedingly rare, and our Keokuk material generally is too limited for a detailed comparison of forms. But we have a specimen of the *A. verrucosus* type, apparently *A. pernodosus* of

is probable that *A. brontes* and *A. unicarinatus*, Hall, which are described from Nauvoo, and which we were unable to identify, never seeing an authentic specimen, belong to these intermediate forms. Among specimens from the transitionals, we have found one in which, as if foreshadowing the peculiar arm features of *A. Lowei*, some of the arms were *simple*, while *others divide* an inch above their bases into two branches. This type also having reached its culmination in the Keokuk beds, comes here extinct.

5. PLATYCRINUS, Miller.

Mr. F. B. Meek, in Hayden's Reps. U. S. Geol. Surv. of the Territories, for 1871, p. 373, proposed the name *Eucladocrinus* as a subgenus for the reception of a type of *Platycrinus*, in which the radial series are extended into long, free tubes, bearing the true arms along their sides. Some lately acquired material from the crinoidal beds, and especially the fish bed, enables us to add something to present knowledge of this form. The type under consideration has exactly the body structure of *Platycrinus* up to the third radials. It includes both the low, broad cup-shaped, and the elongate form of calyx. But instead of giving off the arms in clusters from the third radial as usual in *Platycrinus*, it has the radial series of the body, both dorsal and ventral, enormously extended in the form of tubular free rays, from which the arms spring alternately on either side throughout their length. It bears the same relations to the typical *Platycrinus*, that the form, described as *Steganoocrinus* by M. and W. in vol. II, Ill. Geol. Rept. p. 195, does to the typical *Actinoocrinus*, it being sometimes impossible, with our present knowledge, to determine to which genus the specimen belongs when the arms are removed.¹

The value of these differences in arm arrangement as to generic relations is as yet an open question; but we have found that the structural difference between the two forms is not by any means so great as first impressions would indicate. The free rays of *Steganoocrinus* are actually nothing but extreme developments of the lobes of *Actinoocrinus multiradiatus* or *A. Lowei*, and in like

¹ A similar variation in the arms is observed in *Hexacrinus*, those of *H. brevis*, Goldfuss, being similar in type to the earlier forms of *Platycrinus*, while *H. limbatus*, Müller, has arms of different type, somewhat like *Eucladocrinus*, but more like *Baryocrinus*.

manner the radial extensions of *Eucladocrinus* are produced by a multiplication of the orders of radials in the body of *Platycrinus*, as proved in the most satisfactory manner by our *Platycrinus prænuntius* herein described, in which the intermediate stage is shown. We doubt whether there is any generic distinction between the two forms, but in the unsettled state of our science upon this question, it is probably best, and may facilitate the search for a natural classification to recognize subgeneric groups however artificial they may be.

This group includes, so far as known, our *Eucladocrinus millebrachiatus*, *Platycrinus pleurovimenus*, White, besides *Pl. Montanaensis*, Meek.¹

It ranges in our rocks from the Upper Burlington through the transition beds and into the Keokuk limestone.

Another species, somewhat similar to *E. millebrachiatus*, both in ornamentation and form of the calyx, but having the arms of true *Platycrinus*, ranges through the crinoidal beds and is called *Pl. sculptus* when found in the Lower Burlington, *Pl. glyptus* in the Upper, and *Pl. Saffordi* when found at Keokuk localities. We can see no difference between them, and it is an interesting confirmation of our opinion, that we have before us a specimen from the Burlington limestone at Quincy, kindly loaned to us by Prof. Worthen from the Nat. Hist. Museum of Illinois, which is exactly like some of our Lower and Upper bed specimens, and which was

***Eucleodocrius millebrachiatus*, n. sp.**

Column very large and long, twisted, composed of joints which increase in thickness as they recede from the body. The faces of the joints are eccentric elliptic, the rim beveled to an edge, sometimes sharp and sometimes obtuse, from which project, rather irregularly, small tooth-like spines. Each joint is twisted so that the long axes of the reverse faces make a considerable angle with each other, while the articulation on the long diameters imparts a rapid twist to the whole stem, and permits motion in all directions. The articulating processes run lengthwise of the face of the joint, and consist of a strong ridge along the middle, with another on either side near the periphery, and curving like it. There are deep depressions on either side of the median elevation, probably filled by interarticular substance. Perforation of the column round and extremely minute, barely large enough for the insertion of a fine needle point.

Body, exclusive of free rays, of medium to large size, cup-shaped to elongate hemispheric. Basal and first radial plates thin; basal disk low, about one-third the height of the body. Facet for attachment of the column slightly indented, and surrounded by a low annular ridge, or by a row of small tubercles. Surface of basal plates marked by rows of small nodes and rugose ridges, arranged parallel to the margins and radiating to the angles, the same ornamentation extending upward on the first radials. Edges of basal plates obtusely bevelled. There is considerable diversity in the surface sculpturing, it being obscure on small specimens, conspicuous on large individuals. First radials higher than wide, their sides about parallel, margins not bevelled, but forming close edges with adjacent plates; gibbous in the middle and swelling toward the margin of the second radials. Articulating facet large, oval, semicircular, occupying one-third to one-half the height, and one-half to one-third the width of the plate, facing outward and parallel to the vertical axis. Anal plate about equal in size to the interradials, inflated above, and forming a part of the dorsal dome. The anal opening situated at its upper margin.

Beyond the first radials, the rays extend out horizontally, both to the dorsal and ventral side, and are produced into long free linear, arm-like appendages, which are really extensions of the body of the radial series. They bifurcate on the second radial into two branches, which do not immediately diverge, but remain

united by their inner sides as far as the middle of the third radial plate, beyond which they become free, and continue so to their extremities. Hence, there are two free branches to each ray, or ten in all, each of which bears the true arms on either side in alternate succession. The branches are of about uniform size for half their length, after which they taper gradually and apparently terminate in a true arm. A tubular passage, arched over by the extensions of the dome, runs the entire length of the free rays. The tubes of the two branches, after uniting on the inside of the second radial, connect with the central visceral cavity.

Second radials very short, broad and deep, filling the entire surface of the articulating scar, rounded below, curved at the sides to meet the dome plates, their transverse outline about semicircular, dorsal aspect obtusely pentagonal, though actually heptagonal. The lateral extremities of this plate, like those of the succeeding radials, have angular faces interlocking with corresponding faces of small plates, which fill the interbrachial areas on the ventral side of the rays. The upper equal faces of the plate slope at a very obtuse angle, and bear two plates in succession, which are radials of the second order. The first of these is short, hexagonal, its long margins about parallel, its outer lateral margin notched by a small channel, which penetrates through the plate to the tubular cavity within. The inner lateral margins of this and the next interlock with those of correspo- 112

radial of each series and the outer face of the succeeding plate, they also abut against the plate above and below. In one very large specimen, in part of the ray near the body, they are imbedded still deeper, so that they touch five plates of the ray, as is the case in *E. pleurocymenus*, but at a greater distance from the body they abut only against four, as is the general rule.

The arms are long, rather strong, gently tapering, directed along the rays toward the extremities; composed of a double series of rather short interlocking plates, every alternate one on either side giving rise to a long, slender, single-jointed pinnule. The arms are given off from each pair of plates in the free rays, alternately on each side, thus giving an arm for every two plates throughout their length. In one of our specimens, of medium size, there are about 30 arms to one branch, but the extremity is not preserved, and we have reason to think they averaged 10 more, which would give 40 to the ray, or 400 in all. In some of the larger specimens, the number was doubtless much greater, and probably in some cases approached 500.

Dome flat, composed of comparatively large plates, the apical and radial dome plates being at their middle part abruptly elevated into papillate nodes with a roughened or wrinkled surface. The plates of the interradii areas, of which there are but few, are small. At the place where the rays emerge from the inner body, directly over the second primary radial, there is a large dome marking the incipient bifurcation of the ray, with several smaller ones below, succeeded by two rows of very large, extremely prominent plates like those of the dome, but much more conspicuous and with coarser surface markings. The latter are placed along the ventral side of the ray, and alternately on either side, so that one plate is always situated over the base of an arm, and by counting them the number of arms can be determined as exactly as from the radial plates on the dorsal side. The spaces between these brachial dome plates are occupied by smaller, flat, rounded, or subspiniferous plates, irregularly arranged. The arrangement of the vault pieces of the rays is such that they could not have opened, and hence the passage within was always tubular and never an open canal. The radial appendages have a tendency to bend downward, leaving the ventral surface exposed.

We have noted the presence of a small channel at the lateral extremity of the first radial of the second order, and will now add

that this forms the passage of a good-sized pore. Similar pores, pierced through at the edge of the plate, and inclosed by the abutting margin of an adjacent plate, are found on each side of the free rays near the base of every arm. They communicate with the tubular passage, and have about the same direction as the arm furrows. One pore penetrates every first brachial piece on each side of the arm-base, another enters at the outer lateral edge of the first radial of each order, a third one occurs at the edge of the second radials; but toward the upper or thinner part of the rays, we found only two pores between each pair of arms in place of three as described.¹

¹ The presence of the pores in the sides of the radial appendages is such a notable feature in the form under consideration, that interest is naturally awakened as to their probable functions, and this the more since similar pores have been observed by us in several other genera. They are very conspicuous in *Batocrinus*, where they are arranged in ten pairs, five radial and five interradial, each pair is situated between the adjacent arms, and they connect through the body walls with the inner cavity. They are found also in *Acinocrinus* and *Strolocrinus*, in the free arm bearing rays of *Steganocrinus*, within the false arms of *Ollacrinus*, and pores are found in the ventral sac or so-called inflated proboscis of some of the *Cyathocrinidae*. If now we compare the position of these openings with the so-called ovarian openings of the Blastoids and the pectinated rhombs of the Cystidians, which are considered by some authors to be ovarian, by others respiratory organs, the question is forcibly suggested whether these may not have had the same function as the latter, and as a madreporic organ.

In the investigation of this species we have made use of a magnificent series of specimens from the fish bed, found within a few feet of each other. There are nine individuals in good preservation presenting to view almost every aspect of the fossil, they represent different stages of growth, and show the gradations from small to large individuals. We have also before us a specimen from the division bed at Nanvoo and three from the Keokuk limestone. The latter are considerably larger than the fish-bed specimens, but exhibit otherwise, in the parts preserved, no essential difference. Only a portion of the rays is preserved on one of the Keokuk specimens but sufficient to show that it had the same arm structure. Until discovery of more perfect specimens shall prove the existence of more important differences than yet observed, we can only regard the Keokuk form as belonging to the same species, with the tendency to variation generally observed in Keokuk representations of Burlington types.

This species is distinguished from *E. pleurorhynchus* by the low discoid calyx, the flat concave base, the massive body plates, the deep sutures, the more robust and rapidly tapering radial appendages of that species. In four specimens, we find that the free rays are always folded inward upon the ventral side instead of hanging down as in our species. It has about the same number of arms as ours, and either of them with their ten long rays fully extended, and the hundreds of arms stretching outward must have presented a very striking appearance.

Locality and Position.—Near Burlington, Iowa; transition bed between the Burlington and Keokuk limestone. Collections of C. Wachsmonth and Frank Springer.

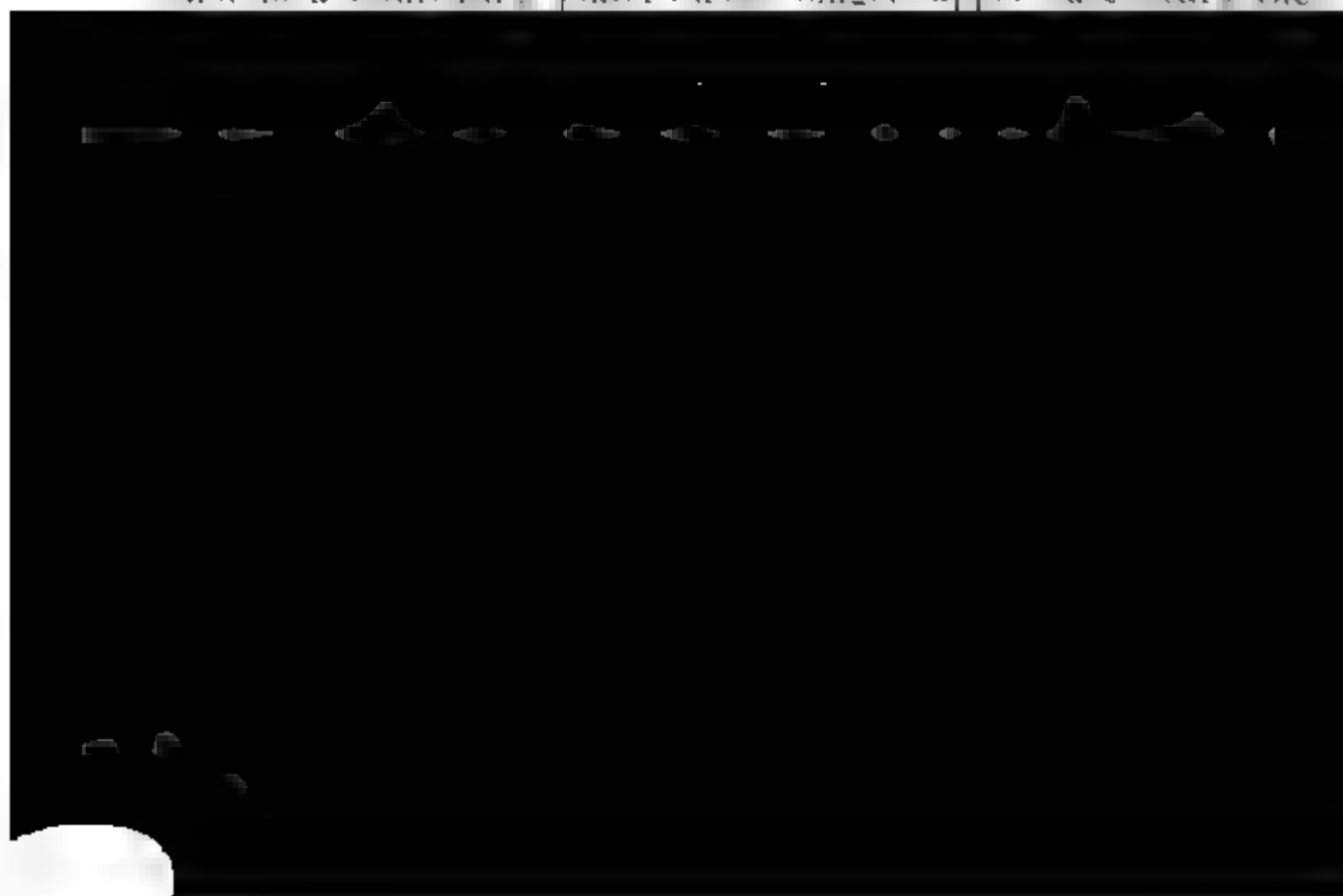
Platyerianus prænatus, n. sp.

Column large, twisted, and constructed as in *E. millebrachiatus*. Base rather large, low, broadly cup-shaped or discoid. Basal and radial plates heavy; basal disk deeply and abruptly excavated below, so that four or five joints of the column are inside the plane of its outer rim. Basal plates elevated near their margins into a thickened, rugose rim, which is also found near the outer margin of the first radials. All the plates are broadly and evenly bevelled on their margins. First radials one-half wider than high, their lower projecting margins overhanging below the middle of the base, so that the body rests on these margins when

placed upon a level surface. Articulating facet prominent, much elevated by the thickening of the plate; broad, semicircular, occupying about one-third the width and height of the first radial, its surface about parallel with the plane of the plate, which makes an angle of about 45° with the vertical axis. Anal plate a little larger than the inter-radials, supporting on its upper face a series of small dome plates, above which is the anal aperture, situated very low and opening laterally.

The radial areas are produced into free appendages, approaching the structure of *Eucladocrinus*. They are large, strong, and broadly rounded below, spreading out about horizontally and folding upward on the ventral side. They bifurcate on the second radial, but remain joined by their inner sides to the top of the second plate above it, where they diverge and become free. The branches diminish in size very rapidly, giving off arms alternately on either side to about the twelfth plate, where each terminates in a bifurcating plate, from whose equal upper faces two true arms diverge. The surface of the plates is irregularly elevated and rounded, and the sutures are slightly sinuous, giving to the rays a wrinkled or corrugated appearance.

Second radial short, broad, filling the articulating faces, pentagonal in outline, bearing upon its upper obtusely-sloping faces the radials of the second order, two in succession, whose inner edges join, but do not interlock, the sutures in the two series coinciding. The first radial of the second order is about quadrangular, its upper and lower margins flexuous. The second is much narrower and is a bifurcating plate, whose longer upper face bears the



Dome elevated, hemispheric, composed of large tumid plates, of which the apical and interrarial ones are the most prominent, the radial area in the vault being composed of a double series of smaller plates, which extend out along the ventral side of the rays as continuations of the dome.

This species, in its body structure, is most closely related to *E. pleurovimenus*, having a similar low discoid form and heavy plates, but it can be easily distinguished by the extremely deep excavation of the base below, the prominent ridges at the margins of the basal and first radial plates, the extreme depth and width of the bevelings at the sutures, the elevation of the articulating faces, and by the very distinct arm structure. It resembles *P. suberosus*, Hall, in its discoid dorsal cup, but in that species the calyx is much lower, the arm-bases being in the plane of the base. The deep and acute beveling of the margins of the plates in our species gives it a sharp, angular appearance not visible in any other species.

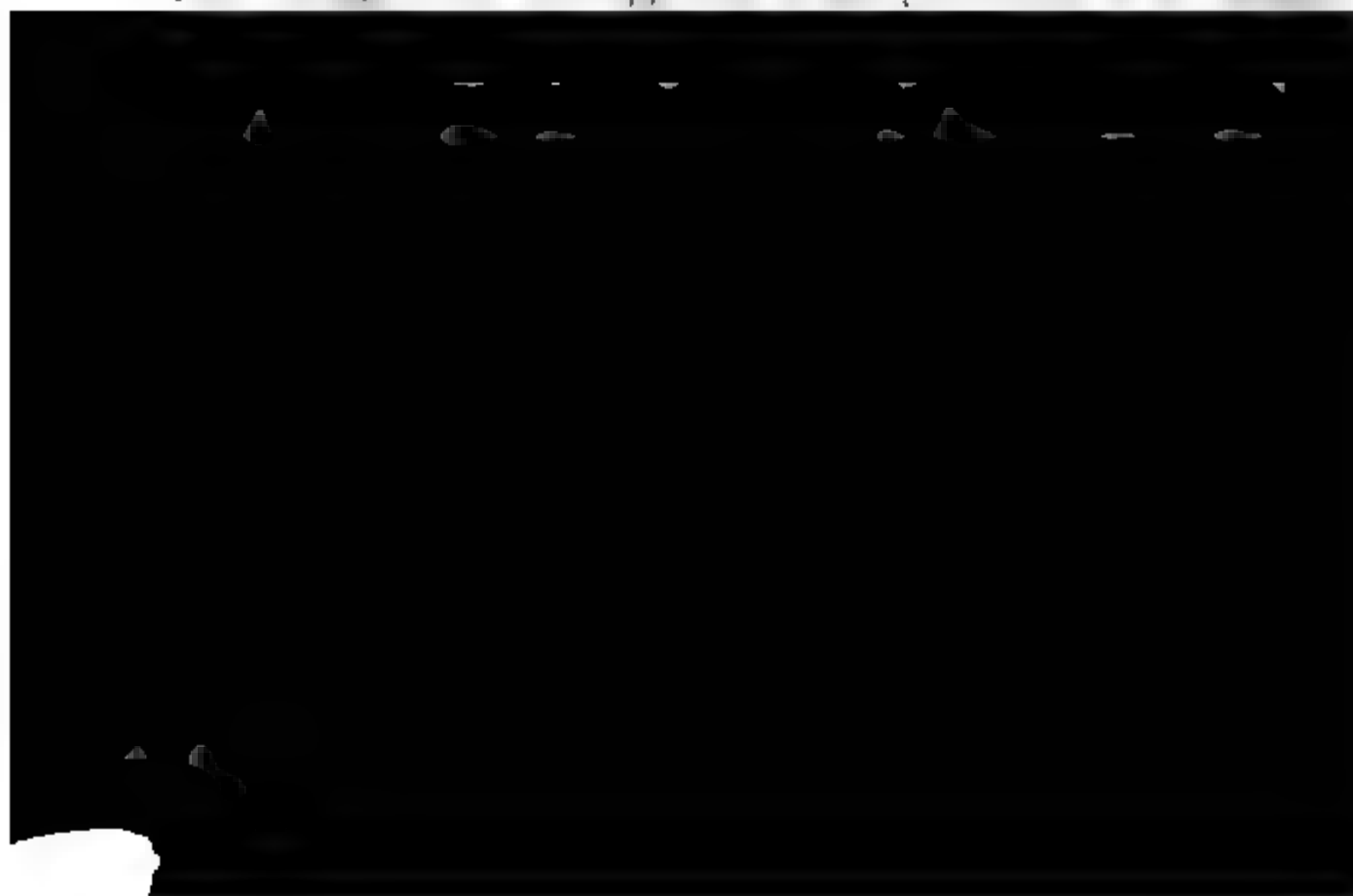
Position and Locality.—Upper Burlington division of the crinoidal limestone; subcarb., Burlington, Iowa. Collections of Fr. Springer and James Love, Esq.

Platycrinus prænuntius, as stated before, represents the transition form between the typical *Platycrinus* and *Eucladocrinus*, the latter being the extreme wing of the genus. A comparison of the species of *Platycrinus* occurring in the Upper and Lower Burlington beds, gives further interesting results concerning the history of the genus. In all the species from the Lower bed the arms, both of the discoid and of the elongate form, divide upon a triangular or pentangular bifurcating plate having equal sloping faces, and the two halves of the rays are free above the second radial, or become so at the first radial of the second order; while in almost every species from the Upper bed the arms branch off alternately from the smaller sloping face of a more or less cuneate plate (similar to *P. prænuntius*); and while we find on the former not over four arms to each half ray, with abnormally a fifth one, there are species in the Upper bed with seven, eight, and nine arms to each half, or eighteen to the ray. There are before us some most interesting specimens of a form from that horizon, perhaps of *P. Halli*, Shum., but more probably, at least if Meek and Worthen's identification of that species in vol. V, Ill. Geol. Rep. P. 454, is correct, of an undescribed type which, in the form of the

body and the general plan of its radial construction, is so intimately related to our *E. mallebrachiatus* (as *P. prænuntius* to *E. pleurovimenus*) that one is forcibly struck with the idea that the former may possibly represent a younger stage of the latter. That this, however, is not the fact, is proved beyond doubt by a number of specimens of each species and of different size, which show the greatest constancy in their respective characters; and, as the two forms occur in a distinct horizon, we are compelled to regard it as not individual growth, but as a more mature development of the genus.

6. ICHTHYOCRINUS, Conrad.

In investigating some specimens, apparently of this genus, of a new form and unusual size from the fish bed, we encountered much difficulty in determining their generic relations, and were accordingly led to an examination of the entire literature of this and its allied genera, *Taxocrinus* and *Forbesiocrinus*. Meek and Worthen, in vol. II, Ill. Geol. Rep. p. 269, have discussed the relations of the two last-named genera, and have furnished good reasons for considering *Forbesiocrinus* to be only a subgenus of *Taxocrinus*. The generic formula, which includes both, is shown to be: 3 basals, which are sometimes rudimentary, 5 subradials, and 3 or 4 \times 5 radials. It thus appears that the only difference between the two forms is in the interradial and anal areas, *Taxocrinus* being either without plates in these spaces or having but 1 to 3, and *Forbesiocrinus* having from 7 to 30, or more. *Taxocrinus* ranges from the Upper Silurian up, while *Forbesiocrinus*



no interradians or anals. Specimens of *I. Burlingtonensis* before us distinctly show the presence of 3 rudimentary basals mentioned by Hall as probably of generic importance, and this would make the formula: basals, 3; subradials, 5; radials, 3×5 ; thus agreeing precisely with *Tarocrinus* and *Forbesiocrinus*, except in the absence of anals and interradians.

The discovery of our new species *I. nobilis* brings fresh confusion to the subject, and obliterates at once this apparently satisfactory distinction. In this species, in young and mature individuals, we have 1 to 3 to 5 interradians, 1 to 2 interaxillary plates, and 3 to 4, mostly 4, primary radials with a wide variation in the radials of the second and third orders, sometimes in the same individual. On the other hand, Hall describes, in the Journ. Acad. Soc. Nat. Hist. 1861, p. 261, under *Forbesiocrinus Thiemei*, another Burlington form, of which the typical specimen (without doubt adult) had neither anal nor interradian plates. Thus showing in a most satisfactory manner, that the interradians may be present or absent in either type. In Hall's species, the radials are 3 & 5, which increase in size upward, the second order of radials, and sometimes partly the third order, leaning against those of the adjacent rays. This species agrees up to the top of the secondary radials most remarkably with *Ichthyocrinus*, and only differs in the upper series of radials, or free arms, which are rounded at the back in place of being flat as in that genus. That we have also found other specimens with 0 to 1 and 3 interradians in one or more areas, and even 5 or more in its representative from the Upper Burlington bed, cannot diminish the weight of our argument. It rather serves to prove more conclusively, that the presence or absence of these plates is of but little value even as a specific character. Hence there remains no distinction as to the true structure between the three genera. The Burlington forms of *Ichthyocrinus* are readily recognized by the level plates and uniform curvature of the body, the disposition of the arms which rest closely against each other and infold at their tips, the waving sutures, and rapidly increasing width of the primary and secondary radials. In *I. laevis*, Hall, the plates are obtusely angulated, while in *I. angulatus* the surface of the radials is elevated in the center, and in *I. corbis* the margins of the radials are straight, while *Forbesiocrinus* and *Tarocrinus* have undulating sutures for a greater or less extent. Thus, the only constant character is

the closely joining and infolding arms of *Ichthyocrinus*. Under this state of facts it seems clearly impossible to longer maintain generic distinctions between the three forms. As *Ichthyocrinus* is the oldest name it must take precedence, and *Taxocrinus* and *Forbesiocrinus* be considered, at the most, as subgenera under it. But whether even this separation can be upheld seems to us doubtful. That in *Ichthyocrinus* the arms join and infold, that the basals are rudimentary, only visible from the inside, that in *Taxocrinus* and *Forbesiocrinus* those plates are more developed, appearing externally, are no *bona fide* features upon which to found subgenera, and yet, they seem, with our present knowledge to be the only constant characters for separation; in all others we find such an easy gradation from one species to another, such an intermingling of characters among the three types, that it appears almost impossible to draw a line where the one genus shall begin and the other end.

Ichthyocrinus nobilis, n. sp.

Column round, comparatively small, and with small spiny processes in the periphery of every alternate joint. Central perforation moderately large with pentapetalous section.

Calyx large, forming with the closely folded arms a smooth, subglobose or ovoid body. Basals not visible; the five subradials seen only at the angles. Primary radials, four to the radius and a half times as wide as high, widest at the distal margin.

ing 12 arms to each full ray or 60 in all. All the radial and plates have a very irregular outline, the bifurcating plates being pentangular, the others more or less quadrangular, with additional small angular faces. The upper and lower margins of the plates are strongly undulated and deeply depressed in the middle somewhat as in *Forbesiocrinus*, and showing in the secondaries of radials very obscure patelloid plates. The undulating nature extends even to many of the lateral margins; the tendency throughout the whole body being to curved lines. The surface of the plates is smooth and level with the others, except the gentle curvature which accommodates them to the general sphericity of the body,—that is to say, the surface of the body is uninterrupted by any elevations or surface angularity of the plates. The arms are flat, comparatively broad, and lie close together, touching at their sides, the lines of junction being straight. The plates both of arms and body are very thick and heavy; those of the arms have on their inner or ventral side a deep furrow with another smaller and shallower groove on either side. Between the rays, there is a set of interradials, extending upward in a wedge-like arrangement from a little above the level of the primary radials, filling a considerable space. There are in full grown specimens from 3 to 4 interradials of rather large size, but we find in one apparently very young individual only a single plate and only one interradial space. Between the first branches of the rays, there are 1 to 2 interaxillary plates which are narrow and elongate. These plates, as a transverse section of one of the rays shows, are cuneate or pyramidal, their apices directed outward and wedged between the radials; and in this case, the interaxillary, though large and massive, had not penetrated through the wall, none being visible from the outside.

This species is readily distinguished from all described forms of the type by its 4 primary radials and its interradial plates. From *Tarocrinus* and *Forbesiocrinus* it differs in its subglobose form, uniform surface, the flatness and close infolding of the arms.

Position and Locality.—From the fish bed at the top of the Upper Burlington division of the crinoidal limestone; subcarb., near Burlington, Iowa. Collection of C. Wachsmuth.

7. CYATHOCRINUS, Miller.

This genus is remarkable for the persistence which some of its forms maintain throughout the crinoidal formations. A careful examination of the prevalent Burlington forms (both from description and numerous specimens), which we were induced to make in connection with some unique forms from the fish bed, gave interesting results. The common species described, and most numerous represented in all the collections that have ever been made at Burlington, are *C. lowensis*, O. and Sh., *C. decurcatus*, and *C. malvaceus*, Hall, always considered lower bed species, and *C. viminalis*, Hall, from the upper bed. The identification of these species in large collections has always been attended with difficulty, except those specimens of this type found in the upper bed, which were promptly referred to *C. viminalis*, it being taken for granted, in pursuance of common understanding which had acquired the force of law, that the same species could not be found in both beds.

If the descriptions of these four species be considered together, it will be found that but one species is represented, with slight variations in the form and proportions of the plates. According to the description, they all have small, subglobose bodies, with basal plates minute to moderately large; subradials proportionally large, equilateral to wider than high, and obtusely angular to

cover to mark the forms from the two beds is, that in the Upper bed specimens, the arms generally taper slightly more than in those from the Lower bed. The similarity, indeed identity, in all other respects, is so striking, that we see no other course than to consider them all as one and the same species, which would fall under the older name *C. Iowensis*. We have been forced to this conclusion only after the most faithful investigation of the abundant material at our command, and in which the collections from the different horizons are authentic. But our difficulties do not end here. We find this same form occurring not unfrequently in the typical Keokuk localities, and indicating not only a striking persistence of type throughout the whole crinoidal formation, but similarity of specific characters quite remarkable. It is described by Prof. Hall as *C. parvibrachiatas*, and, in the specific characters named by him, it agrees with the Burlington type in every respect except the more rapidly diminishing size of the arms. Numerous specimens from various localities show that this feature is quite variable, and one series of 18 individuals, from near Bonaparte, Iowa, collected there in a thin layer not over two feet square, and preserving the arms, shows the same intermingling of minor characters and variety of size as is found in the Burlington forms. One of these specimens, placed beside a similar individual from the lower Burlington, presents to the eye scarcely a point of difference. On an average, however, we find the Keokuk specimens to be a little larger, their arms stronger in the lower parts, and more readily tapering than in those from Burlington, and hence we do not feel at present authorized (nor do we wish to do so when it can possibly be avoided) to interfere with the specific name. Some other species of *Cyathocrinus* in the Keokuk limestone tend toward more robust forms and heavier arms, and among the fish-bed beds we have discovered several forms departing from the characteristic types in the same direction, of which we describe two new species.

***Cyathocrinus barydactylus*, n. sp.**

Column very large, larger than in any known species of the genus, its projecting joints more or less serrated, central perforation of moderate size, and obscurely pentapetalous. Body of medium size, bell-shaped, turbinate below, abruptly spreading in the first radials, greatly constricted at the dome. Diameter at arm bases about equal to height, though less in smaller specimens.

Internal cavity egg-shaped, smallest below. Basals large and prominent, more than two-thirds visible beyond the column, the visible part pentangular, directed upward, and forming a cap whose sides make a very small angle with the vertical axis. Subradials large, higher than wide, four hexagonal and one heptagonal, their surfaces slightly convex. First radials about as wide as high, greatly thickened toward the margin of the articulating facet, and their upper margins very strongly incurved, so that the diameter of the dome is about equal to that of the internal cavity at the middle of the subradials. Anal plate about one-fourth the size of the first radials, higher than wide, and supporting the plates of a lateral upright proboscis. Body plates thick and heavy, especially the first radials, marked by a coarse irregular rugose ornamentation, which is least observed in the first radial. The sutures are rather deeply marked. Articulating facet flat to slightly concave, much elevated, facing outward, about parallel with the vertical axis, and occupying about two-thirds the area of the plate. Its outline is elliptic, notched on the ventral side by the arm furrow. Succeeding radials free, broadly and deeply rounded, two-thirds as wide as the first radials, forming very strong rays of nearly uniform diameter, one bifurcating on the fourth free radial and two on the second, the others not being seen, exhibiting in this respect an irregularity common to the genus. The plates below the bifurcation are quadrangular as

le with a comparatively small, though deep furrow of tripartite form, which extends throughout the arms. The contraction of the body at the summit is very similar to that in *Poterioerinus* (?) *symetricus*. Goldfuss (*Sphaerocrinus*, Roemer), of the Eifel, as illustrated by Schultze in his monograph Pl. V, Fig. 6. The thickness of the first and the succeeding radial plates in this and the succeeding species might suggest a reference to *Barycrinus*, but the arm structure and column at once proves it to be *Cyathocrinus*.

This species differs so entirely from all other described Burlington forms, that comparison is unnecessary, and the only species occurring elsewhere to our knowledge, which at all approach it, are from the Keokuk limestone; as for instance *C. multibrachiatum* from Crawfordville, Ind., which has also a turbinate body, but is otherwise quite distinct.

Locality and position same as last. Collections of C. Wachsmuth and Frank Springer.

***Cyathocrinus* Gilesii, n. sp.**

Column comparatively small, projecting joints rounded on the sides, central perforation small, obscurely pentapetalous. Body compressed, cup-shaped, two-thirds as high as wide, though a little elongate in young specimens; slightly expanded at the base of first radials, and so deeply and abruptly constricted at the same, that the diameter at the upper margin of the plates, in the specimens, is about the same as that at the outer angle of the basal plates, thus making the internal cavity nearly spherical.

Beak comparatively small, about one-half their size exposed above the column, forming a nearly flat disk, with the points of the plates inflected upward at a slight angle with the plane of the axis. In young specimens, these plates are more prominent and inflected upward at a greater angle. Subradials large, about as wide as high, and of the usual form, strongly convex to tumid. First radial very large, more than half the height of the calyx, elevated above the margins of the facet, and their upper margins abruptly and deeply incurved. There is only one anal plate in line with the first radials, and it is of about one-fourth their size; the succeeding plates form a part of the proboscis which is placed obliquely with an upward direction. Body plates comparatively thin, excavated in the inside. Surface destitute of ornamentation.

Articulating facet moderately elevated, flat to concave, and above parallel to the vertical axis; its outline circular and notched by the arm furrow. Succeeding radials form free rays, which are cylindrical, thick and strong, the plates having the same transverse outline as the facet. The free radials are irregular in number, and like the arm plates constricted in the middle, as in *Carydactylus*, with the exception that in our present species the second radial is much shorter. Sometimes, especially when the facet is quite concave, the latter plate is wedge-form with its thin edge directed outward, so that the plate itself is only visible near the ventral side of the ray. The arm furrows converge at the centre of the dome. Five rather prominent so called consolidating plates of deltoid form, placed at the sutures, and resting in the thin incurved margin of two adjoining first radial plates, connect with each other by lateral extensions beneath the furrow, leaving an opening in the centre. Both central opening and furrows were undoubtedly covered with small plates, which have not been preserved in our specimens, but we found one in which a part of the arm furrow is covered by interlocking plates, similar to the arm covering of *C. Iowensis*, described by C. Wachsmuth (Am. Journ. Sci. vol. XIV, Sept. 1877, p. 183).

This species has some features in common with the preceding one, and had we but a single specimen we might well consider it an abnormal variation from that type. But having before us

Location and locality same as C. barydactylus. Collections of Wachsmuth and James Love, Esq.

8 OLLACRINUS, Cumberland.

The form which we include under the above generic name, has been described by Phillips as *Gilbertocrinus*, by Hall as *Trematocrinus*, and by Lyon and Cassidy as *tiomasteroidocrinus*. Meek and Worthen, in vol. II, Ill. Geol. Report, p. 217, have given a very full review of the literature of the subject, together with an able discussion of the characters of this interesting genus, which have been, in some respects, entirely misunderstood by earlier writers. The true nature of the foramina in the upper part of the cranial series was shown to be that of arm openings; while the pseudo-brachial appendages, which were described as arms by Hall and others, were demonstrated to be not arms, but entirely independent organs, supposed to be connected with reproduction or nutrition. To their very instructive observations, to which we refer as the basis of our remarks, we are enabled, by the possession of more perfect material, to add some interesting facts. With Meek and Worthen we cannot agree, however, in regard to the nomenclature of the genus. Cumberland, in 1826, proposed the name *Ollacrinus* for this type, and gave very good figures by which it may be recognized with much greater facility, indeed, than by Phillips's generic diagnosis and descriptions. According to the rules of the British Association, Cumberland's name is, without doubt, entitled to priority. Neither can we see any sufficient reason for separating the genus into two sections, as proposed by those authors. Authentic specimens of the three European species, *Gilbertocrinus calcaratus*, *G. bursa*, *G. nanus*, Phil., show that the pseudo-brachial appendages occupy at the same relative position to the arm-openings as in the American species, and that they are not situated over the inter-brachial or radial spaces, but over the interradial areas. We are inclined to believe that the misconception of the nature of the pseudo-brachial appendages led to a misunderstanding of the arrangement of the body plates, and that the interradial series was mistaken for the radial one. There is some variation in American specimens as to the position of the arm openings dependent upon the direction of the arms. In the specimens in which Meek and Worthen found the true arms preserved, they

were pendent, and from this fact it was stated that in this genus the arms were always pendent, and not erect as in the allied *Rhodocrinus*. We find this true in the species named, as also in *O. typus*, Hall, of the Upper Burlington; but in *O. tuberculosus* the arms are erect and fold upward over the dome; and, while in the latter species the arm furrows and pinnules are placed like those in other crinoids on the upper or ventral side, they are, in *O. typus*, upon the under or apparently dorsal side. The same is the case in *O. tuberosus*, L. and C., from Crawfordville. This peculiar structure is easily explained if we consider that the pendent position of the arms in these species is due, not to a forcible bending out of their normal attitude, but to the peculiar construction of the brachial parts, which directs them downward and makes this their natural position; and, while it appears as if the arm structure was entirely reversed in these two types, this is really not the case, the furrow is still on the ventral side, but the arms have rotated on their axes so as to bring it on the inner side when hanging down.

We have before us some twenty-five specimens of this genus, mostly of *O. typus* and *O. tuberculosus*, about half of them having the false arms, and eight the true arms preserved also. The two species are very satisfactorily separated by characters, the most of which were not disclosed to the learned paleontologist who described them, by the material at his command. We therefore give briefly their additional distinctive characters.

Ollaerinus typus. Hall (sp).

Intercostals and axils varying from 7 and 11 in young speci-

The ambulacral furrow is on the under side of the arms, and bears pinnules which point downward. *Trematocrinus papillatus*, Hall, seems to be identical with *O. typus*, for we find both the papillate tubercles and long spines on specimens which undoubtedly belong to the latter.

***Ollacrinus tuberculosus*. Hall (sp.).**

Anal and interradials about thirteen in adult specimens. Pseudo-brachial appendages without ornamentation, short, small, rapidly tapering to a point. The true arms, as observed in three specimens, are directed upward and folded over the dome, with the ambulacral furrow and pinnules on the inner side, as usual in *O. typus*. Arm openings in small cavities on either side the base of the false arms. Arms composed of a double series of plates and arranged as in *O. typus*. There are apparently four arms to the ray, although in one instance a fifth one was observed. Body plates large, tuberculiform, and not spiniferous. This, as well as all other Burlington species, has two secondary radials (supra-radials), and not three as stated.

In the fish-bed locality the *O. typus* existed in vast numbers, but although the fragmentary remains of upwards of a hundred individuals were traced there, only a few were found in fair preservation. They were mostly of larger size and more robust form than specimens from other localities; the tubercles on the joints of the false arms were fewer in number and larger, while the body plates were less prominently spiniferous.

O. typus robustus, Hall (sp.), from Keokuk, seems to be larger and more robust than the Burlington species, but the structure of the false arms is not described, and we have never seen an authentic specimen of that species.

1. *O. verrucosus tuberosus*, L. & C. (sp.), the only species of the genus described from the Keokuk limestone of Crawfordville, Indiana, there is a marked distinction from the prevalent Burlington types in the false arms which are composed at their bases of four ranges of plates above and two below. It is therefore an extremely interesting fact to find that in *O. oboratus*, M. and W. (sp.), which occurs only at the very uppermost part of the Upper Burlington beds, there are also four ranges of plates in the upper part of the false arms, which is the case in no other Burlington species. This is one of the rarest fossils of our rocks, only three specimens having ever been found, to our knowledge; and in this

isolated crinoid we have another instructive illustration of the structural transitions by which types are modified in the successive epochs.

9. DORYCRINUS, etc.

The history of this genus in the Crinoidal limestone is of great interest. The species of the Lower Burlington are small, and all have a single spine which is on the apex of the dome. *D. unicornis*, O. and Sh., is occasionally found with three, in which case the nodes of the radial dome plates in the posterior rays are prolonged into small spines—an abnormality upon which Hall founded his *Actinocrinus tricornis*. This latter species cannot be upheld, as we find those plates in every stage of development from nodose to spiniferous; sometimes only one plate is prolonged, the other one being normal. Yet, this variation is exceedingly interesting as showing the first step toward a modification which, in the Upper Burlington and Keokuk beds becomes a constant character; in the species of those two beds the first radial dome plates, not only of the posterior ray but of every ray, are prolonged into long spines. The lower bed *Dorycrini* have heavy arms, flattened toward the tips, and closely resembling those of some species which Meek and Worthen refer to *Eretmocrinus*, but differing from them in being double from their origin instead of single, as in *Eretmocrinus*.

secondary spines. This species, *D. Gouldi*, with its extraordinary feature of spines on spines, was exceedingly short-lived, and disappears already in the lower part of the Keokuk, where it first occurs.

A very similar case is that of *Strotocrinus*, Meek and Worthen (Ill. Geol. Rep. vol. II, p. 181), which, in its typical form, began in the Upper Burlington, though its ancestry is very readily traced in certain Lower Burlington forms. It apparently found favorable conditions in the upper beds, for several species at once developed extreme proportions, the rim at the brachial disk extending in some specimens nearly an inch and a half from the body all around. These large forms are a very common and characteristic fossil in the middle part of the upper bed, but above that they are scarcely ever seen. The smaller types are found somewhat higher, but the genus is extinguished in this formation, not a single specimen having ever been found in the Keokuk.

Barycrinus has a similar history. Commencing in the Lower Burlington in species of moderate size, it becomes in the Keokuk, through transition forms, which are with great difficulty separated into varieties, one of the leading genera, and attains in *B. magister*, Hall (sp.) and *B. magnificus*, M. and W., a gigantic size. These large forms disappear with the Keokuk, and the isolated species found in later formations are small in size and of rare occurrence.

Amphocrinus appears in the Lower Burlington, where it at once develops extraordinary features in the dome, which is extended into a large, but short proboscis, surrounded by very strong spines, which sometimes give off four or five branches as large as the primary spine. It reaches in America its climax in the Lower Burlington, and no trace of it is found in any succeeding formation.

Monocrinus, Owen and Shumard, after attaining an immense size, perishes in the Upper Burlington. *Zocrinus*, on the other hand, like *Cyathocrinus*, in its more prevalent small forms, ranges almost unchanged through all the crinoidal beds, it being very difficult to distinguish those from a different horizon by definite characters. It even continues to flourish in somewhat similar forms in the later formations.

It seems, from the foregoing observations, to be a general rule of the crinoids of these formations, that extravagant forms and

rank developments in structure are not perpetuated, and that types mostly cease to exist when they reach a culmination in anatomical features.

We have also seen that, although crinoidal life existed abundantly throughout the formations under consideration, a large proportion of the genera did not survive them; that where extinctions of generic types occurred, it was generally upon their attaining a climax in growth; that the extinguishment of specific forms was not coincident with the close of the respective epochs of limestone deposits, but that most of the changes were made by a series of slow and gradual modifications of specific characters, which correspond in a striking manner with the changes in individual life by growth; that the silicious deposits, while accompanied by great changes in the crinoidal forms, instead of marking sharp distinctions between the limestone formations, exhibit the gradations by which they are connected; that the smaller and less conspicuous forms were generally persistent, and ranged through the whole crinoidal formations with comparatively little change.

We have by no means given all the data at our command bearing on the subject, and our knowledge is necessarily limited. Much further research is required before a thorough understanding of the questions herein discussed can be expected. We are satisfied that a comparative study of the other organic remains, so abundant in these rocks, especially the Fishes, Brachiopods, and Bryozoa, would yield facts similar to those observed in the crinoids. But, however imperfect our investigations, we believe the evidence tends strongly to prove that the distinctions said to exist between

JUNE 4.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-four persons present.

The death of Wm. M. Gabb was announced.

The Law Governing Sex.—Mr. THOMAS MEEHAN referred to his observations originally reported to the Academy, developing an entirely new view of the laws of sex from that formerly prevailing, and which proved that what we called the female sex or final reproductive element in flowers, required a higher grade of nutritive power to perfect than the male. Though numberless facts have proved this point, there have always been some which, though they have offered no obstacle, have at least not been capable of explanation by the light of this theory, and among these have been some connected with dioecious plants. Among hermaphrodite and especially among monoecious plants there has been no difficulty in tracing the operation of this principle. In such coniferous trees as pines, firs, and larches, there is no difficulty in perceiving that branches once bearing female flowers, and maturing cones and seeds, produce nothing but male flowers when the branches come in time to be weakened by the shade of younger branches, or in some other way are imperfectly nourished. But when we come to the red cedar, *Juniperus Virginiana*, where some trees are always wholly male, and others always seed bearing, no difference could be found in the vigor of the trees. As in the monoecious cases we found the female element in exact proportion to nutritive advantages, we looked for the seed-bearing trees of the red cedar to be more vigorous than the males, but found instead all equally vigorous and healthy.

The enormous crops of seed borne by the silver maple this year, together with the confirmation of their truly dioecious character, have not only furnished an explanation of the apparent anomaly, but at the same time affords one of the best possible illustrations of the new theory.

As already noted in communications to the Academy, the sexes in *Acer rubrum* and *Acer dasycarpum* are alike in all trees when the petals first open. The anthers seem perfectly formed at another stage of growth commences. The pistils elongate in the female flowers while the filaments remain stationary, and the anthers never open; while in the male flowers the pistils do not grow, but the filaments elongate, and the anthers are carried on to perfection. Each tree is in fact strictly a male or a female tree.

It is a matter within common knowledge that after the maturity of the immense crop of seeds last month, the bearing trees were

comparatively leafless; while the completely barren male trees abounded with foliage. There is a well-known morphological law, that the parts of flowers and the resulting seed vessels are metamorphosed leaves. In the case of these maples, the female trees, engaged in developing primordial leaves to perfect fruit, make few leaves in addition to those they started with in the spring, until, after several weeks, their fruitage has been completed. But the male flowers, dying immediately on perfecting their pollen, the male trees push at once into a heavy leaf growth, clothing the tree at a very early period with a dense foliage.

But another consideration intrudes itself here. The woody parts of a tree are made up mainly from the atmosphere through the medium of the leaves, and we may suppose that the greater the proportionate amount of leaves, the greater would be the woody product. Applying now these acknowledged principles to these maple trees, we find some remarkable results. Notwithstanding the male trees are relieved from the enormous strain on the powers of nutrition which the annual and often wonderfully heavy crops must entail, and notwithstanding they have, as in many cases this season especially, the advantage of a hundredfold more foliage at so early a period in the season, male trees are no larger, vigorous, or in any way more healthy than the female ones. In a crowded group of five trees where a female tree is the central one, and a male on the outside, the male with every advantage of food for the roots, and light and air for its large crop of leaves, and which happens to be an unusually large mass of foliage even for a male maple, the girth of the trunk is four feet three inches, while the crowded female tree is five feet five inches, or two inches larger, with all its disadvantages!

We have been looking for weaker individuals in the male than in the female trees. But since he had first made his discoveries we have learned to distinguish much more clearly between vegetative



reg. of the Academy by Dr. Harrison Allen. He had received it from a gentleman who informed him that he had picked it up in the neighborhood of a silver mine in Mexico. The grass near the mine was contaminated with silver amalgam, and the sheep were said to have been poisoned by the herbage. The peculiar tartar on the teeth was supposed to consist of silver amalgam.

Upon examination it was found that the tartar formed a thin scale covering the teeth so far as they were exposed. The thickness was about 0.2 millimeter. When viewed under a lens of moderate power the deposit seemed to have been built up gradually from within, for, on breaking, a series of very thin layers were exposed of which the outer one appeared darker than those underneath. The scales were very fragile. Its lustre was truly metallic, so that light could pass through it even on the thin edges, but the lustre of the reflected rays of light were decidedly metallic, and this property was alike throughout the scales. These scales did not allow an impression to be made with the nail of the finger, but they were harder than silver amalgam. If heated on platinum foil it blackened, showing the presence of organic matter; the form of the fragment did not change during the heating, but the silvery lustre entirely disappeared. Heated in the tube closed at one end, at first a gray cloud arose, then water and an oily matter deposited themselves on the upper or cooler end of the tube. Lower down near the now carbonized test a metallic layer was recognized with the aid of the lens. The powdered substance being mixed with carbonate of soda, and treated in the same way the result did not differ. If melted on coal with the addition of carbonate of soda there was obtained a white enamel but no metal whatever. In nitric acid the tartar was soluble as long as the solution was concentrated, if diluted with water a turbidity, caused by the separation of an organic matter, was formed. This organic matter was soluble in caustic ammonia and from this ammoniacal solution it was again precipitable by nitric acid; the precipitate was flocculent, not at all cheesy, it carbonized when dried, and left no residue if the heating was prolonged for a sufficient time.

The remaining solution from which this organic substance had been separated gave no reaction with hydrochloric acid, the absence of silver being thereby proven.

A stream of sulphuretted hydrogen gave a precipitation in which a very little quantity of sulphuret of mercury was discerned. Very strong reactions of phosphoric acid and lime were observed in the nitric acid solution with the ordinary reagents.

This singular tartar is consequently not silver amalgam but the same material of which teeth are generally made, modified, however, by the influence of a small quantity of mercury. That metallic mercury is easily absorbed by the animal economy is well known, it seems, however, not to have been noticed on the outside of the teeth before.

JUNE 11.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-one persons present.

The following papers were presented for publication:—

"Description of a New Fossil from the Cretaceous of Charleston, S. C." By Wm. G. Mazyck and A. W. Vogdes.

"On Unio subrostrata." By James Lewis, M.D.

JUNE 18.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-one persons present.

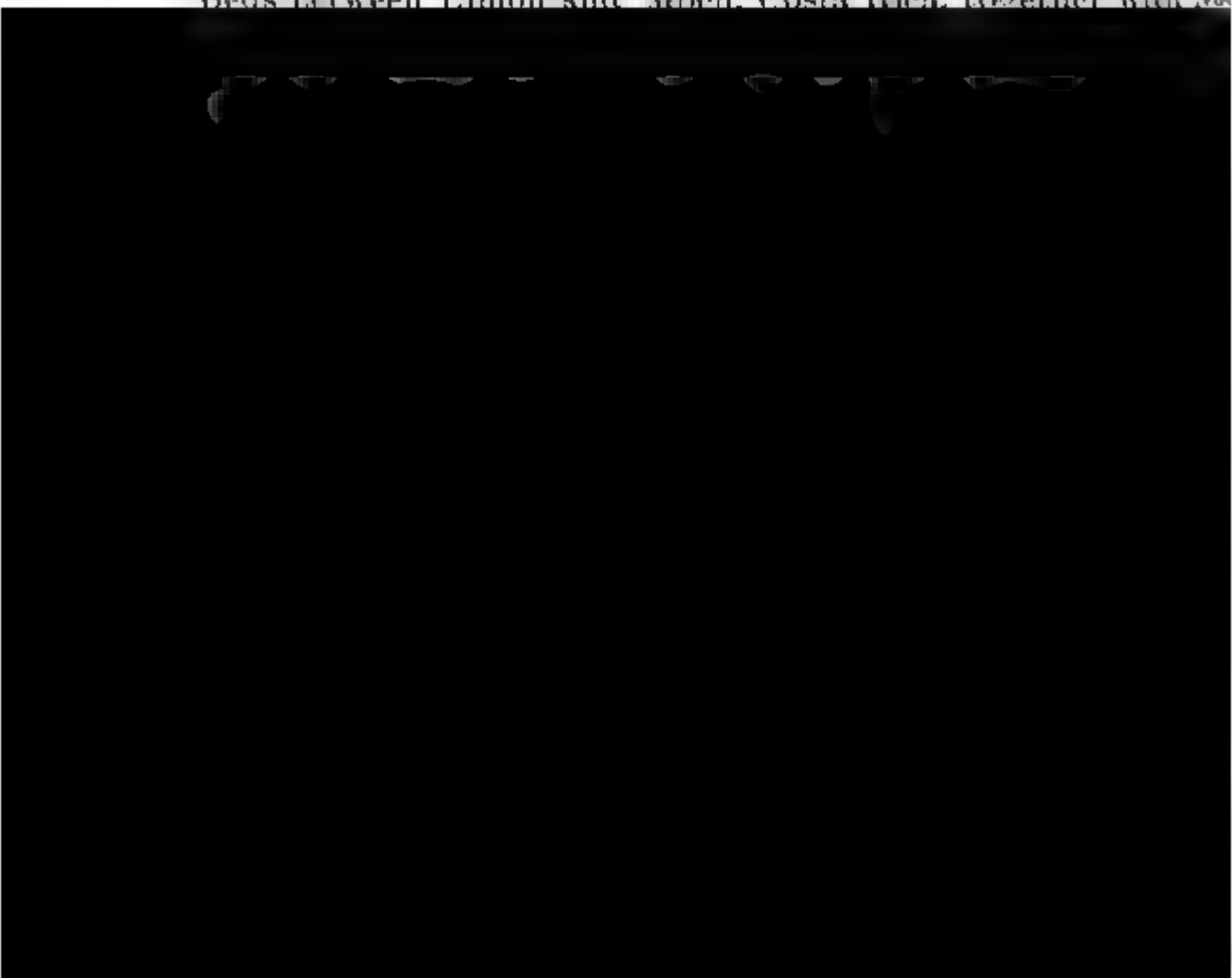
JUNE 25.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-seven members present.

The following papers were presented for publication:—

**"Descriptions of New Species of Fossils from the Pliocene Cl
Beds between Limon and Moen, Costa Rica, together with Not**



JULY 9.

The President, Dr. RUSCHENBERGER, in the chair.

Thirteen persons present.

The death of Mr. Bloomfield H. Moore was announced.

The following papers were ordered to be printed:—

DESCRIPTION OF A NEW FOSSIL FROM THE CRETACEOUS BEDS OF
CHARLESTON, S. C.

BY WM. G. MAZYCK AND A. W. VOGDES.

Anomia Andersoni, M. & V. n. s.

Description.—Shell thin, suborbicular in outline, but somewhat irregular; beak subcentral, marginal; hinge line almost straight; upper valve moderately convex. Lower valve unknown. The surface of the upper valve is regularly marked with obscure lines of growth and concentric wrinkles, the latter become prominent laminae towards the ventral margin.



This shell will be readily distinguished from all other species of the genus by its marked regular prominent concentric wrinkles. It preserves the peculiar pearly lustre, characteristic of the genus remarkably well.

The greatest diameter of our Fig. 1 is 18 mm., and its smallest diameter is 15 mm. The convexity of this specimen is about 4 mm.

Position and locality.—Cretaceous period: artesian well on the Citadel Green, Charleston, S. C. The shell ranges between the depth of 1880 feet to 1930 feet below the surface. We have also

ON *UNIO SUBROSTRATUS*, SAY.

BY JAMES LEWIS, M.D., MOHAWK, N. J.

The records which relate to *Unio subrostratus* afford a curious instance of the obscurity in which the identity of a species may be involved through the influence of trifling errors. Practically up to the present time *U. subrostratus* has had scarcely more value in scientific records than if it had never been described.

To dispel the obscurity which invests this subject, the records which most essentially bear upon the identification of the species will now be offered for consideration, commencing with Say's description of the species transcribed from page 134 of W. G. Binney's edition of Say's conchological writings.

"*UNIO SUBROSTRATUS*, transversely elongated, subrostrated, radiated.

Inhabits Wabash.

Transversely elongate subovate, brownish or pale ochreous, with numerous dark-green radii; beaks but little elevated with a few small, angular, concentric lines; ligament margin a little compressed; anterior margin¹ somewhat elongated, hardly subrostrated; separated by an obtuse angle from the ligament margin; base arcuated; posterior margin rounded; within white, often slightly tinted with flesh color; somewhat iridescent on the margins, particularly the anterior margin; substance of the shell not thick; teeth very oblique, crested.

Length one inch and two-fifths; breadth three inches and one-fifth. Convexity hardly over one inch.

This may be said to be the analogue of the *U. nasutus*, nob. of the western waters. The rostrum, however, is not so definite, and it is a more convex shell. The aged shell is dark-brown, but near the beaks reddish-brown."—January 15, 1830, New Harmony Discriminator.

Subsequently Mr. Say put *Unio iris*, Lea, in the synonymy of *subrostratus*,² and this mistake on the part of Mr. Say may be presumed to be the source of the obscurity that *subrostratus* has

¹ Say reversed our present understanding of the anterior and posterior of *Unio*.

² See page 225, Binney's ed. of Say.

since been involved in. There is no evidence to show that Mr. Say had any other knowledge of *U. iris* than a reading of Mr. Lea's description of that species.

Mr. Lea in his treatment of synonymy, follows Say's idea of the identity of *iris* and *subrostratus*, but places *iris* first. See Synopsis (1870), page 60. This serves to make the obscurity still more complete, and were it not for Mr. Lea's foot-note to *iris* on the page just cited, *subrostratus* might for all time have remained in the synonymy of *iris*, or what amounts to the same thing, the two might continue to be regarded as identical. As Mr. Lea's foot-note affords an important hint by which the identification of *subrostratus* is approached, it is here transcribed.

"Mr. Say in his *Synonymy*, gives *iris* as a synonym of *subrostratus*. If they were the same I would be entitled to precedence, as my description bears date March, 1829, while his is January, 1831. His description, however, of *subrostratus* does not apply to my *iris*, and certainly this shell could not have been under his eye when his description was made. He says that the *subrostratus* 'may be said to be the analogue of the *Unio nasutus* (nobis) of the western waters.' As the *U. nasutus* inhabits the western waters, a variety of that species may have been described by him for *subrostratus*."—Lea's Synopsis, 1870, page 60, foot-note 4..

The most significant parts of the above note are underlined

In endeavoring to ascertain the facts which bear upon Mr. Lea's closing sentence in the above note, I have obtained specimens of *U. nasutus* from the northern counties of Ohio, the streams of which flow into Lake Erie. In Indiana, Illinois, and Iowa my



enixville, Chester Co., Penna.; Dr. R. M. Byrnes, Cincinnati, Ohio; Dr. J. Schneck, Mt. Carmel, Illinois; J. M. McCreery, Wadon, Ohio; Philip Marsh, Esq., Aledo, Illinois; Prof. F. M. Winter, Muscatine, Iowa; Dr. E. R. Showalter, Alabama. I am indebted to the records of the Hayden Exploring Expedition for facts in geographical distribution.

PELAGIC AMPHIPODA.

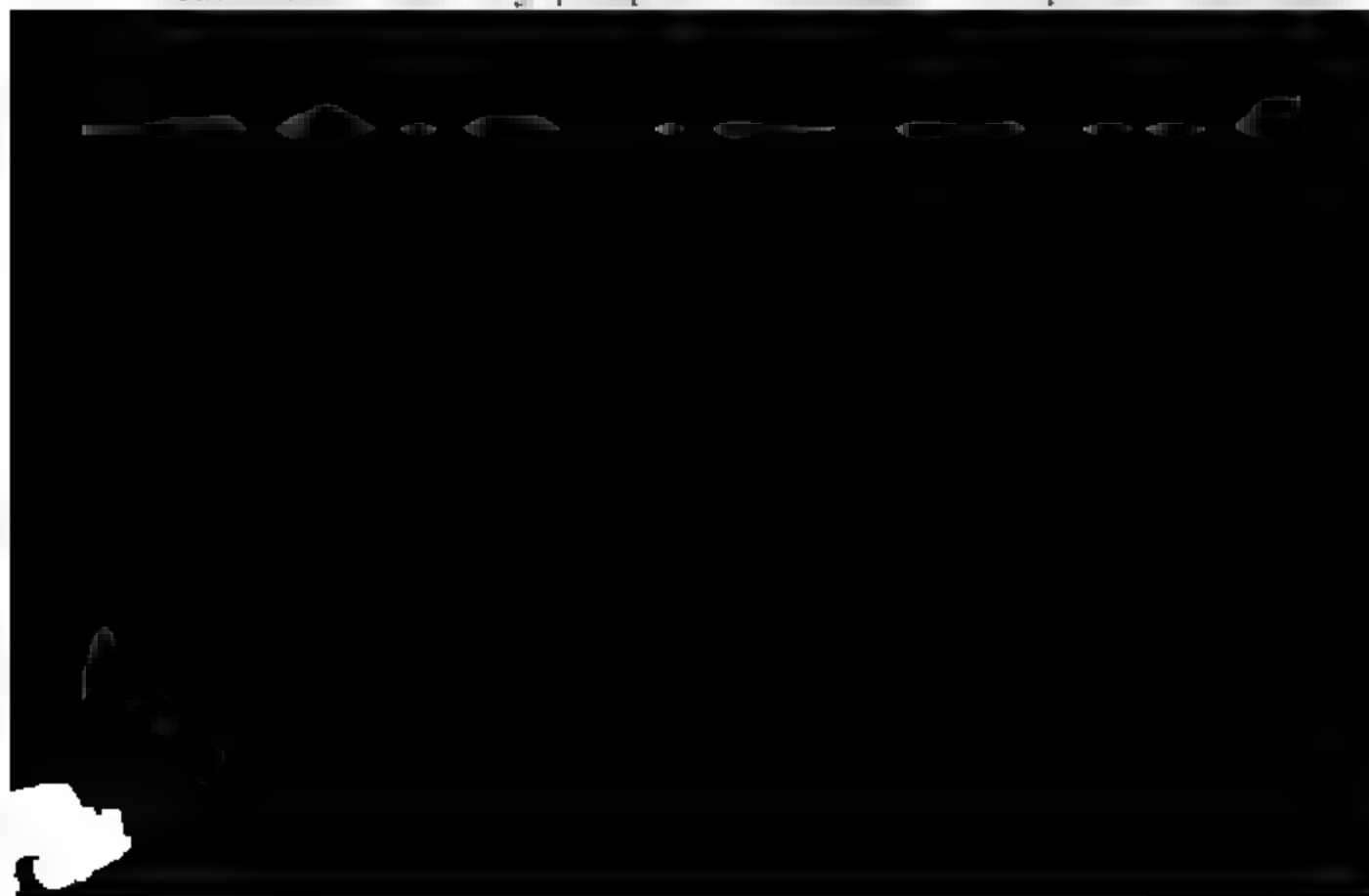
BY THOMAS H. STREETS, M.D., U.S.N.

The crustaceans to be discussed in this and subsequent papers "are oceanic species, and are mostly found remote from the land." They belong to Dana's subtribe *Hyperidea*, and to Bate's division *Hyperina*.

There is a remarkable contrast between the two great divisions of Amphipoda—the *Gammaridea* and the *Hyperidea*. The former are generally found along shore, in deeper water near the bottom, or on floating material, and there is a great resemblance running through all the species; while the latter swim free in the mid-ocean, and there is the greatest diversity of characters among them.

The collection, which has been placed in my hands for identification, is probably the largest which has ever been gathered together by a single individual. It was collected by Surgeon William H. Jones, U. S. Navy, and his work embraces a period of about four years. It comes from nearly the entire Pacific Ocean, north and south of the equator, except the extreme high latitudes. A portion of it now enriches the Academy's collection, and the remainder has been retained by the collector.

The specimens were mostly taken with a towing-net at night, which is "about the only time when surface dredging can be carried on with any prospect of success." (I quote from the



the night have great influence in effecting their approach to the surface or within reach of the dredge. A smooth sea, a dark night, especially if cloudy or squally, or warm and sultry, seems to be their favorite time for approaching the surface in the greatest numbers; while, on the other hand, a moonlight night, or high winds, and a rough and heavy sea, keep them from coming so near the surface.

"Usually they approach the surface about twilight, or within half an hour after dark, and remain on or near the surface for two or three hours, although occasionally they remain much later, being apparently influenced by the darkness of the night and state of the weather."

I attach much importance to these notes, as they give the first information we have had of the habits of these little animals. I have noticed myself that a great many of them, when alive, have the property of phosphorescence, and it has occurred to me may it not be this which causes them to shun the light? They carry their own light about with them.

OXYCEPHALIDÆ.

Body elongate, narrow. Head lengthened in the direction of the axis of the body, and produced anteriorly beyond the superior antennæ in the form of a pointed rostrum. Eyes occupying the greater portion of the head, posterior to the superior antennæ. Antennæ on the inferior surface of the head; the superior (anterior) pair short; the inferior (posterior) long, and folded upon itself four times, and concealed in a groove on the under surface of the head. Mandibular appendage long. The inferior antennæ and mandibular appendage are absent in the female.¹ First and second pairs of the thoracic legs small, and chelately developed. The basal joint of the three posterior pairs of thoracic legs broadly flattened, except in some species of *Rhabdosoma*. The last pair of legs smaller than the preceding; either rudimentary developed or obsolete. Caudal appendages lanceolate, or linear; biramous. Telson broadly triangular, or linear.

¹ Claus classifies the *Oxycephalidæ* along with the *Phronimidæ* in his family *Phronimides*, and states that the mandibular palpus is absent, which is an error. Though absent in both sexes of the *Phronimidæ*, it is present in the male of the *Oxycephalidæ*.

OXYCEPHALUS, Edwards.

Body moderately long, robust. Head narrow, produced anteriorly in a broad, triangular rostrum, short, grooved below; a constriction of the head may, or may not, exist behind the eyes and in front of the first thoracic segment. The superior antennæ three-jointed, the middle joint short; inferior antennæ five-jointed, joints subequal, except the last, which is short. Mandibular appendage three-jointed. The first and second pairs of thoracic legs short, clawed; the third and fourth simple; the last three pairs with the basal joint broadly dilated; the last pair diminutive or rudimentary; the extremity of the sixth pair—articulating with the broad basal joint—finely serrated along the anterior margin. The sixth abdominal segment broad, not elongated. The caudal appendages short, broadly lanceolate. Telson broadly triangular.

Oxycephalus tuberculatus, Sp. Bate. Fig. 1, 1a, 1b.

Oxycephalus tuberculatus, Sp. Bate, Catalogue Amph. Crust., 1864, p. 343, pl. 54, fig. 5.—Streets, Bulletin of the National Museum, Washington, 1871, p. 136.

Head long, almost equal to the first five segments of the thorax, broad, deeper posteriorly than anteriorly, superior surface straight, on a level with the dorsum of the thorax, inferior margin convex, sloping upward anteriorly; rostrum short, somewhat more than half the length of the head, broad, triangular, acute, lateral edges

the segments, commencing and terminating in the tubercles on each segment, similar ridges descend from the tubercles along the front and after margins of the segments; along the side of the thorax are a number of short ridges, irregularly placed. On the side of each of the three anterior abdominal segments is an oblique ridge, forked posteriorly, the median dorsal ridge of the thorax gradually disappears on the abdominal segments. The first and second pairs of thoracic legs short, perfectly chelate; the first shorter than the second, the fourth joint short, produced antero-inferiorly, but not to the apex of the fifth joint, acute, spinous on the lower and anterior edges, serrated on the latter, antero-superior angle acute, projecting forward, the fifth joint articulating with the fourth below the superior angle, convex above, lower edge straight and serrated, spinous, dactylus short, slightly longer than the anterior edge of the fifth joint. The hand of the second pair more elongate, the fourth joint produced antero-inferiorly to the apex of the fifth joint, and the tip slightly curved upward, the fifth joint oblong, in other respects resembles the first pair. Third and fourth pairs of legs subequal, simple, with a few hairs, or spines, along the posterior edge, the fifth pair the longest, with the hairs arranged along the anterior edge, the anterior edge of the sixth pair pectinated, fine teeth in the intervals between the larger ones, basal joint of the last three pairs of legs broadly lobed, the sixth shorter than the fifth, but broader, margins finely serrated, the seventh pair of thoracic legs diminutive, the basal basal joint narrowing distally, the remaining portion of the leg shorter than the first joint. In the smaller specimens the length of the seventh pair about equals the length of the basal joint of the preceding pair, but in the larger specimens it is somewhat longer.

The inferior margin of the first three abdominal segments furnished with two sharp, prominent spines directed downward and outward, and separated by a deep notch; one is situated on the middle of the inferior margin, and the other projects from the posterior angle. The first and third pairs of caudal appendages extending backward about the same distance, and reaching to the extremity of the telson, the second pair terminating opposite the commencement of the rami of the last pair, rami serrated, long. Fourth abdominal segment longer than broad. Telson broad, triangular, serrated.

No. examined.	Localities.	Temp. water	Temp. air.	Lengths.	Sex.
1	Lat. 32°23' S. Long. 98°30' W.	64°F.	68°F.	28 mm.	♂
2	" 28 47 N. " 124 29 "	63 "	62 "	28 "	♂
3	" " " " " " " "	" "	" "	20 "	♂
4	" 35 25 " " 142 53 "	61 "	59 "	25 "	♂
5	" " " " " " " "	" "	" "	15 "	♂
6	" 5 00 " " 128 00 "	" "	" "	10 "	♂
7	" 25 23 " " 133 13 "	67 "	67 "	13 "	♂ (young)
8	" 25 13 " " 143 15 "	....	....	14 "	♀

The males of this species are smaller than the females, and there is a slight difference in the shape of the superior antennæ. The peduncle is more robust, and the apex of the last joint is produced; the anterior aspect of the produced portion slopes backward forming an obtuse angle with the main portion of the joint, and is sparsely covered with hairs.

Oxycephalus bulbosus, n. sp. Fig. 2, 2a, 2b.

Female.—Body compressed; head one-fourth of the total length; the portion containing the eyes rounded in profile, equally convex above and below, compressed, the neck portion constricted, but not narrower than the first segment of the thorax; the rostrum one-third the length of the head (its own length included), depressed, narrower than the head when looked at from above.

rather longer than the basal joint of the sixth pair. The postero-anterior angle of the anterior abdominal segments acutely produced, in front of the posterior angle on the inferior margin a small notch, no spine on the inferior border. The first and last pairs of caudal appendages and telson extending about the same distance backward; the second pair terminating opposite the commencement of the last pair and the commencement of the third of the first pair. The sixth segment of the abdomen longer than broad. Telson broad, triangular at apex.

No.	Locality.	Temp. water.	Temp. air.	Length.	Sex.
1	Lat 28° 00' N. Long. 140° 00' W.	70 F.	69 F.	17 mm.	♀
2	" 27° 00' N. " 140° 00' W.	70 "	69 "	13 "	♀
3	" 35° 45' N. " 144° 25' W.	62 "	58 "	14 "	♀

The affinities of this species are with *Oxycephalus tuberculatus*, but is very readily distinguished by the bulbous shape of the head and by the absence of the spine on the inferior margin of the three anterior abdominal segments. There are no males in the collection.

Oxycephalus scleroticus, n. sp. Fig. 3, 3a, 3b, 3c.

Male. — Animal with the tegumentary covering hard and resistant. Head as long as the first six segments of the thorax; the portion containing the eyes rounded and shorter than the part anterior to it, compressed, wedge-shaped, with the broad end of the wedge posterior, constricted in front, and notched behind and above at articulation with the thorax, inferior surface convex, superior surface rounded and sloping downward; rostrum broad, triangular, depressed towards the end, acute, elevated in the median line; in the smaller specimens the point of the rostrum was deflexed; a deep concavity beneath the rostrum for the reception of the superior antennae; the groove for the inferior antennae and labellar palpi long and narrow. Superior antennae bowed in the form of a half-circle, and springing from the posterior extremity of a lengthened elevation on the under surface of the stem, the convex margin densely hairy, the apex of the convex border produced at nearly a right angle with the rest of the peduncle with the middle joint short; flagellum three-jointed and articulating with the base of the produced apex

of the last joint of the peduncle. Inferior antennæ when folded reaching nearly to the extremity of the rostrum, first four joints long and subequal, the fifth short. Mandibular palpus long, first joint long, the last two short and subequal. The thorax elevated along the median line into a broad, rounded ridge, with the sides sloping down from the summit; the ridge appearing somewhat nodulated; a row of nodules along the side above the epimerals; on the fifth epimeral a prominent spine, directed backward; the segments of the thorax decreasing posteriorly, each segment bulging, not overriding its fellow; the whole surface of the body finely granulated. First and second pairs of thoracic legs short, chelate; the first smaller than the second, with the fourth joint broad, produced, apex acute, spinous; the second pair with fourth joint more produced than in the first, the anterior margin of the joint nearly straight; the fifth joint as long as the anterior margin of the fourth, spinous below; claw long, acute. The last three pairs of thoracic legs with the basal joint broadly dilated, and with a series of four pits along the median line of the outer surface of each joint, their posterior edge broadly produced backward near the middle; the basal joint of the sixth pair the broadest; that of the last pair small, its distal margin broad, the entire leg shorter than the first joint of the preceding pair. The three anterior abdominal segments with the postero-inferior angle produced, acute, inferior edge straight; the fourth segment small; the fifth and sixth consolidated, and together as long as the telson. Telson triangular, broad, projecting but slightly beyond the extremities of the caudal appendages. The first and third pairs of



The female of this species is more robust than the male. The head is deeper and broader, more rounded above and below, the notch posterior shallower; the rostrum shorter and narrower. Superior antennæ straight, or slightly curved, slender, not produced at the apex of the third joint of the peduncle. In the one specimen of this sex in the collection the spine on the fifth epimeral was absent.

The figure was taken from the largest specimen in the collection. The head is longer, and the constricted portion behind is broader than in the two other male specimens. In the latter the tip of the rostrum is somewhat deflexed.

LEPTOCOTIS, Streets.

Body long and slender. Head produced anteriorly to the superior antennæ in a long, slender rostrum, constricted posteriorly at its articulation with the thorax, the constricted portion short. Superior antennæ short, three-jointed, curved in the male, and straight in the female; inferior antennæ five-jointed, joints subequal, excepting the last which is short. Mandibular appendage three-jointed. First and second pairs of thoracic legs short, chelate, the third and fourth simple; the last three pairs with the basal joint dilated; the last pair diminutive. The sixth abdominal segment (the fifth and sixth fused) elongated. The caudal appendages long, linear. Telson long, triangular at apex.

This genus occupies an intermediate position, showing the transition from the short *Orycephalus* into the excessively elongated form of the *Rhabdosoma*. Its affiliations are with both.

Leptocotis spinifera, Streets. Fig. 4, 4a, 4b

Leptocotis spinifera, Streets, Bulletin of the U. S. National Museum, Washington, 1877, p. 137.

Male.—Head long, excluding the rostrum, as long as the thorax, deeper posteriorly than anteriorly, gradually narrowing above and below to the rostrum, superior surface abruptly constricted behind, the back on a level with the dorsum of the thorax, the rest of the superior surface elevated above the dorsum of the thorax, straight, slightly arched over the superior antennæ, inferior margin convex, the front hollowed out below on either side into fossæ for the superior antennæ; rostrum slightly more than one-third the length of the head (including its own length), slender, acute, slightly angled. Superior antennæ sickle-shaped, the first and second joints

short, forming the handle of the sickle, the second joint shorter than the first, both together shorter than the broad, curved, terminal joint of the peduncle, margins of the last joint densely hairy, apex produced into a long, stout process, at right angle with the rest of the joint; a short, bi-articulate flagellum articulating with the anterior surface of the base of the process, two or three auditory hairs on each articulus. Inferior antennæ when folded reaching as far forward as the base of the superior pair, the distal extremity of the first joint clubbed, the first three joints equal in length, the fourth somewhat shorter, fifth very short, with one or two hairs at the apex. Mandibular appendage as long as the first joint of the inferior antennæ, the second and third joints short.

First and second pairs of thoracic legs short, chelate; the first smaller than the second, with the fourth joint broad, and produced anteriorly, the produced portion triangular, spinous, the apex long, slender, acute; the fifth joint broad, spinous below and anteriorly, dactylus nearly one-half the length of the fifth joint, curved, with a spine on the inferior edge behind the middle. The second pair of legs similar to the first; the third and fourth pairs simple, slender, shorter than the fifth; the fifth, sixth, and seventh with the first joint dilated; the basal joint of the sixth broader than the fifth, but with the remaining joints shorter, and closely pectinated along their anterior margin; the pectinations on the third joint coarse, on the fourth very fine, while those on the fifth and

No. specimen	Localities.		Temp. water.	Temp. air.	Length.	Sex.
1	Lat 21 37' N.	Long. 152° 28' W.	74° F.	71° F.	11 mm.	♂
2	" 29 00 N.	" 157 00 W.	.....	.....	13 "	♂
3	" 25 13 N.	" 143 15 W.	.....	.....	11 "	♂
4	" 15 38 N.	" 118 00 W.	76° F.	.....	9 "	♀
5	" 16 25 N.	" 118 00 W.	75 "	.....	8 "	♀
6	" 2 57 S.	" 81 40 W.	68 "	73° F.	9 "	♀

Female.—Animal smaller and slenderer than the male. Head oblong, convex above and below, tapering in front and behind, not abruptly constricted at the neck, as is the case in the male; rostrum relatively longer, being equal to the length of the head behind it. Superior antennae slender, straight, not produced at the apex. The thorax increases in thickness towards the middle. The peduncles of the swimming feet oblong.

CALAMORHYNCHUS. n. gen.

Body elongated, slender, almost rod-like. Head large, depressed, produced anteriorly to the eyes in a broadly-expanded, triangular rostrum; constricted behind the eyes into a short, narrow neck. Superior antennae with the peduncle three-jointed; in the female straight. First and second pairs of thoracic legs small, chelate; the fourth joint broad and long, the fifth short and narrow. The next three pairs of legs with the basal joint narrowly dilated; the seventh pair diminutive. The sixth segment of the abdomen long and narrow. Caudal appendages long and linear. Telson short, regular.

Calamorrhynchus pellucidus, n. sp. Fig. 5, 3a.

Fig. 5.—Head long, nearly one-third of the total length, its length twice that of the thorax; neck short, and slightly narrower than the thorax; the portion containing the eyes oblong.

Back above and below when viewed in profile, elevated above, in median line, into a sharp ridge, which terminates at the apex of the rostrum, below the eyes from two long and rounded lobes separated by a broad, shallow groove; rostrum flattened, posteriorly broader than the eyes, commencing on either side of the eyes in a broad, rounded wing-like expansion, and tapering forward to a long and acute apex. Superior antennae situated about the centre of the under surface of the rostrum, small and slender,

with the first and last joints of the peduncle subequal, the middle joint short, auditory hairs at the apex; flagellum bi-articulate, bent forward at its articulation with the peduncle. Segments of the thorax subequal. First pair of thoracic legs shorter than the second; the fourth joint broad, produced, and rounded anteriorly, so that the apex points upward slightly, spinous and serrated, apex acute, short; fifth joint slender, spinous, serrated on inferior edge; dactylus long, slender, acute; the hand of the second pair oblong in shape, fourth joint more elongate than that of the first pair, convex below, apex prolonged, slender, spinous, sharply serrated on anterior edge, fifth joint slender, as long as the anterior margin of the fourth joint, spinous, sharply serrated below. Third and fourth pairs of legs simple; the last three pairs with the basal joint narrowly dilated, lanceolate; the fifth pair the longest; the sixth shorter than the fifth, with the third, fourth, and fifth joints minutely serrated along their anterior margin; the seventh pair diminutive, barely exceeding the basal joint of the preceding pair. The anterior three abdominal segments subequal, the postero-inferior angle acute, projecting. The sixth segment long and narrow, slightly longer than the peduncle of the first pair of caudal appendages. First and second pairs of caudal appendages long and linear, the first stouter than the second, equal in length, falling short of the apex of the telson and the extremity of the last pair, inner margin and rami serrated; the last pair short, about one-third the length of the first pair, slightly shorter than the telson. Telson narrow, acute at apex.

Length, 12 mm. Locality, lat. 28° 06' N.; long. 140° 12' W.

Rhabdosoma whitei, Bate. Fig. 6, 6a, 6b.

Rhabdosoma whitei, C. Spence Bate. Catalog. Amph. Crustacea, 1862, p. 345, pl. 54, fig. 7.

Male.—Length of the head nearly one-half of the total length ($\frac{1}{2}$); rostrum, from the situation of the superior antennæ, three times as long as the rest of the head; the portion containing the eyes shorter than the neck, the superior surface, posteriorly, sloping backward with a gentle incline to the neck; inferior surface straight, anteriorly ascending obliquely to the insertion of the superior antennæ; the neck narrowest about the middle, enlarged at its articulation with the thorax, superiorly very slightly concave, inferior surface straight, on a level with the under surface of the eyes, a narrow and shallow groove running the whole length of the under surface. Superior antennæ with the peduncle stout, sickle-shaped, first and second joints short, third long, broad, curved, with the concavity forward, anterior apex produced into a stout process, hairy; flagellum short. Inferior antennæ long, joints subequal, except the last, in adult individuals when folded longer than the neck, reaching nearly to the middle of the eye-portion. Mandibular palpus as long as the first joint of inferior antennæ, first joint long, last two short. The third, fourth, fifth, and sixth thoracic segments subequal and lengthened, the first, second, and seventh short, the latter about one-half the length of the sixth. First pair of thoracic legs with the fourth joint short, dilated, produced anteriorly to near the apex of the fifth joint; fifth joint stout, inferior edge anteriorly dilated and slightly produced; dactylus long, slender, curved; the second pair of legs longer than the first, fourth joint slender, but slightly enlarged, produced anteriorly in a long, slender, curved process, acute at the apex, and extending slightly beyond the apex of the fifth joint; the latter produced anteriorly at its inferior angle into a short process, toothed, distal extremity of the joint enlarged; dactylus long, curved. The remaining thoracic legs simple, first joint not dilated, as slender as the preceding, increasing in length to the sixth, the third and fourth joints of the sixth pair finely toothed on the anterior margin, the fifth joint coarsely toothed; the seventh pair obsolete. The anterior three abdominal segments subequal, the postero-inferior angle produced into a prominent, acute spine, with a broad, shallow notch in front of each spine, last spine longest; the fourth segment as long as the third, and about three-

fourths the length of the sixth, slender. Caudal appendage long, linear, serrated, biramous, rami short; the first pair reaching backward to about middle of the length of the last pair; the second pair slightly longer than the sixth abdominal segment; the last pair falling short of the extremity of the telson, and shorter than the first pair. Telson cylindrical, tapering to the extremity, which is acute, and slightly defined.

No. EXAMP.	Localities.	Temp. water	Temp. air.	Length	Sex
1	Lat. 27° 17' N. Long. 111° 19' W.	70° F.	72° F.	*45 mm	♂
2	" " " " " "	" "	" "	*39 "	♂
3	" " " " " "	" "	" "	55 "	♂
4	" " " " " "	" "	" "	*42 "	♂
5	" " " " " "	" "	" "	*39 "	♂
6	" " " " " "	" "	" "	*48 "	♂
7	Lat. 16° 25' N. Long. 118° 00' W.	.....	.....	*25 "	♂

Those marked with asterisks had more or less of the point of the rostrum broken off.

In the female the thorax is larger, the superior antennae are small, slender, and straight. The last joint of the peduncle is broad and flattened at the apex, and crowned by a number of hairs. In other respects similar to the male.

The drawing was taken from a female for the reason that the

crowned with hairs. Inferior antennæ and mandibular palpi short. Thoracic segments gradually increasing in length to the seventh, which is about two-thirds the length of the sixth; epimerals long, with the inferior margins finely serrated; the last epimeral contracted in the middle, somewhat dumb-bell shaped. First pair of thoracic legs short, the fourth joint produced anteriorly beyond the extremity of the fifth joint, the process slender, apex acute, inferior margin straight; fifth joint produced antero-inferiorly into a short, broad, triangular process, dactylus long; second pair slender, longer than the first pair, fourth joint produced anteriorly into a very long, slender, curved process extending beyond the extremity of the fifth joint; the latter joint longer, but produced as in the first pair, dactylus long, slender. The third and fourth pairs of thoracic legs shorter than the fifth and sixth pairs, subequal, the fourth somewhat the longer; the fifth longer than the sixth, the first joint of both somewhat enlarged, the anterior margin of the third, fourth, and fifth joints of the sixth pair finely serrated. The anterior three abdominal segments subequal, the posterior and inferior margins of the first meeting at an obtuse angle, not produced; the margins of the second segment meeting at nearly a right angle, slightly projecting; the angle of the third segment still more projecting, the margins meeting at an acute angle; finely serrulated. The sixth segment (fifth and sixth fused) nearly twice as long as the fourth, and the latter about two-thirds the length of the third; the slender posterior abdominal segments and telson spinulose. The first pair of caudal appendages reaching not quite to the middle of the last pair; the latter longer than the former, and extending quite or nearly to the extremity of the telson; the second pair slender, and of the same length as the sixth segment of the abdomen; rami long, ameculate, margins of peduncles and rami serrated. Telson cylindrical, gradually tapering posteriorly, apex acute.

Length, from end of broken rostrum, 45 mm. Locality, lat. 31° 17' N., long. 111° 19' W. Temp. water, 70° F. Temp. air, 72° F.

White named his species on the authority of Milne Edwards, but it was the same as his *Oxycephalus armatum*. I have identified the present specimen with White's figure; they agree in every essential particular. What *R. armatum*, Bate (= *Macrocephalus longirostris*, Bate, Ann. and Mag. Nat. Hist., 3d ser., i,

1856, p. 362) is, I do not know, although both the description and figure are supposed to have been taken from the same specimen that furnished White's figure; namely, the Sir E. Belcher specimen, which was captured during the cruise of the Samarang, and which is the only specimen Mr. Bate claims to have had access to. For some unexplained reason he omits all reference to White's figure, although he refers to the latter's text. Concerning the Belcher specimen, Adams and White say, "We regret that the state of the only specimen in the British Museum is such that we cannot give the generic character with that detail which we should wish." They also state that the drawing was made at the time of capture. The following characters will denote the difference between *R. armatum*, Bate, and the present species: The presence in the former of a tooth on the inferior margin of the fourth joint of the first pair of thoracic feet; of a postero-dorsal spine on the second and third abdominal segments; the non-enlargement of the first joint of the fifth and sixth pairs of thoracic legs (White's figure shows these to be enlarged); and in the relative lengths of the first and last pairs of caudal appendages, the first being longer than the last, and reaching as far backward. I give it provisionally the name *Rhabdosoma longirostris* (Bate). There are other points of difference, but the above are sufficient for the present.

EXPLANATION OF PLATES.

Fig. 1. *Oxycephalus tuberculatus*, Bate; 1a, 1b. First and second thoracic feet.



JULY 16.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

xteen persons present.

JULY 23.

The President, Dr. RUSCHENBERGER, in the chair.

ifteen persons present.

JULY 30.

The President, Dr. RUSCHENBERGER, in the chair.

xteen persons present.

he death of Carl Stal, a correspondent, was announced.

erman C. Evarts, M.D., and Mrs. Emily T. Eckert were elected
ibers.

B. Ellis, of Newfield, N. J., was elected a correspondent.

AUGUST 6.

The President, Dr. RUSCHENBERGER, in the chair.

en persons present.

AUGUST 13.

The President, Dr. RUSCHENBERGER, in the chair.

wenty-one persons present.

AUGUST 20.

The President, Dr. RUSCHENBERGER, in the chair.

ixteen persons present.

paper entitled "Notes on the Natural History of Fort Macon,
C., and Vicinity, No. 5," by Drs. Elliott Coues and H. C.
row, was presented for publication.

AUGUST 27.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-eight persons present.

Foraminifera of the Coast of New Jersey.—Prof. LEIDY remarked that in recent visits to Cape May and Atlantic City he had incidentally examined the shore sands for foraminifera. In both localities, between tides, along the slight ridges left by the receding waves, he had found an abundance of specimens, but they appeared all to belong to a single species, which he supposed to be the *Nonionina millepora*. On the sandy beaches of the rocky New England shores, as at Newport, R. I., and Noank, Conn., he had observed a far greater quantity, of several genera and species.

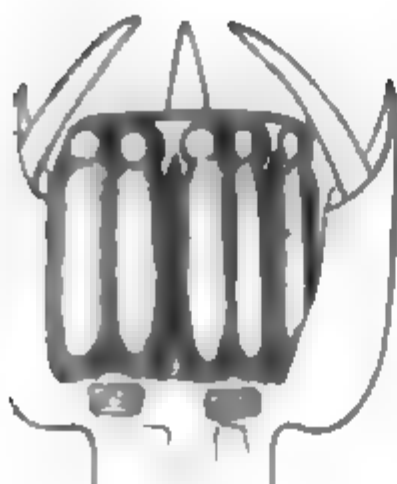
Sensitive Organs in Stapelia—Dr. J. GIBBONS HUNT remarked that his attention had been called to the flower of *Stapelia asterias* by Mr. Isaac Burk, who had expressed the opinion that it was probably a fly-catcher. The flower of this plant is well known to botanists because of its extremely disagreeable and animal odor, which appears to attract many flies when the flower is matured. Continuous observation for several hours, under a lens which took in a large field of view, revealed many flies eagerly applying their tongues all over the petals and essential organs, apparently eating with almost intoxicated relish the attractive excretion covering those parts. This banquet was indulged in in

sative trap, and when touched, however lightly, by the fly or other object (as a hair, for example), the opposing, separated, parallel, and hard edges instantaneously close like pincers, and the prey is secured.

Stapelia belongs to the *Asclepiadaceæ*, and analogous sensitive organs attached to the pollen masses exist in other genera, and perhaps in all that natural order. We have probably no other vegetable fly-catcher so instantaneous in its action as the organ we had described, and he could therefore confirm Mr. Burk's observation.

Sensitive Organs in Asclepias.—Mr. EDWARD POTTS stated that, at the suggestion of Dr. Hunt, he had examined such species of the genus *Asclepias* as were within his reach, with the view to determine whether a sensitiveness and contractile power existed in the dark gland-like bodies associated with their pollen masses,

Fig 1.



similar to those which Dr. Hunt had discovered in *Stapelia*. On account of the lateness of the season, his observations were limited to the *A. incarnata*, native, and a cultivated species, the *A. curassavicum*, and, as these were identical as to the points under examination, his description would be understood to apply to both. The accompanying wood-cut (Fig 1) clearly shows the position and form of the so-called glands (which may be easily seen on the flower by the aid of a pocket magnifying glass), near the extremity of the pistil, just peeping out

from beneath the mantles of adjacent anthers. These latter are very coherent to the pistil, or more properly to its stigma, and

Fig. 2.



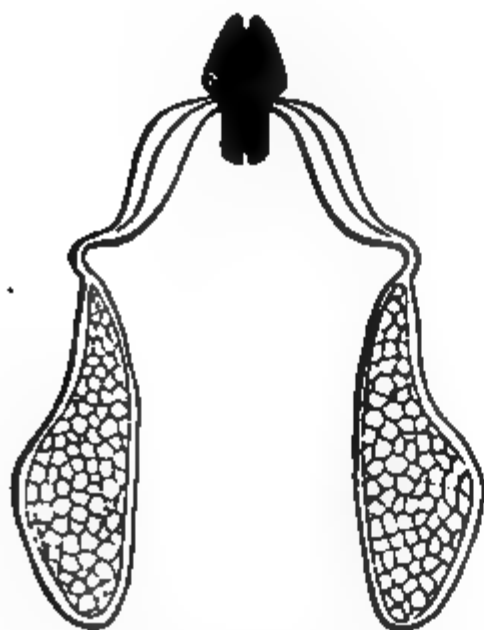
when separated therefrom present, on the under side, the appearance he had endeavored to show in fig. 2, of a pair of sacks or cases in which the pollen masses are suspended, left open at the top apparently with a view to facilitate their withdrawal. The sensitive glands are placed in shallow depressions upon the perpendicular columnar ridges of the stigma, and seem to be attached to it by a very delicate, easily ruptured membrane. Fig. 3 represents one of these as connected by somewhat broad and twisted filaments, with the two adjacent pollen masses of neighboring

anthers, not those belonging to the same. In this sketch he had endeavored to represent it as open and expectant, and in fig. 4, as actually grasping a slender hair. The fact of the removal of these organs by insect agency has been frequently mentioned; his ex-

periments have been made to determine whether the glands themselves took an active part in the matter.

As these species seemed to present few attractions to the insect world, and received but few such visitors, he was compelled to use both force and strategy to accomplish his ends.

Fig. 3.



He at first tried to insert a human hair while observing the gland under the microscope, but failed, on account of the relatively large size of the hair and the difficulty of manipulating it where all directions were reversed. His next plan was more successful; he caught house flies and held them by the wings above the flowers, allowing their feet to scramble over them. Almost immediately one or more of these would become ornamented by groups of the glands and pollen masses which clung so closely that their later struggles and rubbings failed in any case to detach them. The experiment of course

was less conclusive as to the active agency of the gland than that mentioned by Dr. Hunt, where in the *Stapelia*, it closed on the hairs clothing the proboscis of its prey. To avoid

Fig. 4.



the objection that the hooks and spines upon the insect's legs caught and drew out the glands by friction, he tried a modification of his first experiment. Taking a fine camel's hair pencil, he brought its end gently, perpendicularly upon the summit of the flower, sometimes

If it should be conceded from the result of these experiments that there is at least a probability that motion can thus be excited in these glands, it will appear further that the withdrawal of the pollen masses is so far within the plan of creation, that it has not been left to the accident of occasional entanglement in the legs of insects. But to what end is this rude withdrawal? The fertilization of the plant by their rupture upon the edges of the stigma is a very natural suggestion.

But doubt is thrown upon the necessity for this exceptional method of fertilization when we notice the existence of a still more extraordinary one mentioned by Dr. Gray. If we dissect and carefully examine a thoroughly matured flower just before its stigma and surrounding anthers have fallen, we will probably find some of the pollen masses materially modified in appearance from their earlier condition, and sending forth, always from their inner, more convex edge, a great bunch of pollen tubes which penetrate the stigma at its lower extremity where it joins the apex of the styles. In this view, its fertilization, instead of being, as it would appear at first glance, practically impossible without external help, seems almost absolutely certain, failing where our insect friends or some other form of violence may have extracted all the pollen masses before their tubes were protruded, or where the latter may have failed to appear on account of the prior drying of the stigmatic surface.

In this connection he would refer to a recent observation in which he has, though far too few to establish a rule upon the question, observed that they go, tend to confirm the opinion of Robert Brown, derived from his own experience, viz., that fertilization in this class of plants does depend largely upon insect agency. In three instances Mr. Potts had noticed upon flowers of *A. carassacum*, besides the known normal features, another sensitive gland and its associated pollen masses, which must have been brought there by some external agency. In each case one mass of the pair had been inserted under the edge of an anther in the immediate vicinity of the other pollen mass occupying its natural position; that is, the latter was *under* the former was *under* the antherial sack, and the former was close against the sloping lower surface of the stigma. In each of these three instances was not examined more particularly, but the other two forming parts of separate groups of flowers upon the same stem, were marked, the twig kept alive for several days to allow time for the formation of pollen masses, and then carefully dissected. It is worthy of remark that in every other flower of each group had withered and leaving these alone. On dissection it was found that each of the inserted pollen masses had thrown forward a profusion of pollen tubes towards the point of junction of the stigma with the apex of the styles; and though he could not detect their entrance into the latter, fertilization had probably been effected as the ovaries had noticeably increased in size.

None of the masses which occupied their natural position had formed tubes, though in several a strongly marked granulation and tendency to rupture appeared in those cells adjoining the convex inner edge.

If it be allowable to deduce a theory from the observation of so few facts, when these are confirmed by so high an authority as Robert Brown, he would suggest that while there is no imperative physical obstacle to self-fertilization in these plants, the inner membrane of the anther being cut away apparently for the purpose of promoting or allowing it (as seen in fig. 2), yet the maturity of the pollen masses is reached so late that the stigma of the same flower has frequently lost its susceptible condition as to moisture, etc., before that period arrives. When, however, the pollen masses pertaining to one of the earlier flowers are removed by insects and lodged in the position above described upon another just opened, they find and respond to the more favorable circumstances, and cross-fertilize that flower.

A *motif* is thus suggested for the sensitive character noticed in the above described glands, and the care taken, by this means, to insure the frequent transplantation of the pollen masses into other flowers

Dowling Benjamin, M.D., was elected a member.

The following paper was ordered to be published:—

**NOTES ON THE NATURAL HISTORY OF FORT MACON, N. C., AND
VICINITY. (No. 5.)**

BY DRs. ELLIOTT COUES AND H. C. YARROW.

The present paper continues a series of articles which have appeared in these Proceedings, as follows:—

No. 1. By Dr. Coues, Vertebrates (except Fishes). 1871, pp. 12–49.

No. 2. By Dr. Coues, Invertebrates. 1871, pp. 120–148.

No. 3. By Dr. Yarrow, Fishes. 1877, pp. 203–218.

No. 4. By Drs. Coues and Yarrow, supplementary to No. 1, Vertebrates. 1878, pp. 21–28.

No. 5, herewith presented, may similarly be considered as supplementary to No. 2, Invertebrates, as it gives species either identified after No. 2 had been printed, or added by Dr. Yarrow after Dr. Coues had left Fort Macon.

Numerous specimens, notably sponges and ascidians, still remain undetermined, but there seems to be no immediate prospect of identifying them.

Our best thanks are due to Prof. A. E. Verrill, who has been kind enough to revise the present paper, making many additions. We are also indebted for the identification of various specimens to Prof. A. Agassiz, Prof. A. Hyatt, Mr. G. W. Tryon, Jr., and Prof. S. I. Smith.

The classification and nomenclature of this paper are substantially according to Verrill's "Report on the Invertebrates," etc., in the Ann. Rep. U. S. Comm. of Fish and Fisheries, 1873, pp. 293 *et seq.*

The Appendix, with which we are favored by Mr. J. S. Kingsley, will be found a valuable article, complete in itself, on the Decapod Crustacea of the Atlantic Coast, with special reference to those of Fort Macon.

CRUSTACEA.

BRACHYURA.

***Heterocrypta granulata*, Stimpson.**

Was occasionally found in the small mesh gill-nets fished on outside or sea-beach.

MACROURA.

Eupagurus longicarpus, Stimp. (= *E. longipes*, in Dr. Cones's List, p. 124.)

Very abundant.

Alpheus heterochaelis, Say.

Collected by Dr. Yarrow.

Alpheus minus, Say.

Not uncommon. Found in the cavities of sponges, etc.

Tossama carolinensis, Kingsley.

Obtained by Dr. Yarrow and Dr. A. S. Packard.

Crangon vulgaris, Fabricius.

Very numerous on outside beach, and individuals of large size were frequently found in pools left by the receding tide. Smaller ones abundant in the marshy creeks of the sounds.

Palaemonetes vulgaris, Stimpson.

Is abundant on the outer beach; found with preceding species.

NOTE.—In Dr. Stimpson's list of the Decapod Crustacea of Beaufort, N. C. (Amer. Journ. Sciences, Ser. II., vol. xxix. p. 444, 1860), the following species are enumerated, which are not included in this nor in Dr. Cones's previous list: *Pelia mutica*, *Leptopodia calcarata*, *Pinnotherea maculatus*, *Pinnixa cylindrica*, *P. Sayana*, *P. chatopterana*, *Lithadia cariosa*, *Calappa marmorata*, *Porcellana ocellata*, *P. sociata*, *Euceramus praelongus*, *Lepidops scutellata*, *Eupagurus annulipes*, *Calinassa major*, *Alpheus intermedius*, *Virbius pleuracanthus*, *Poncus constrictus*.

SQUILLOIDEA.

rior margin of each of the anterior segments of the abdomen produced into a slender spiniform dorsal tooth," is very common near the mouths of fresh water streams emptying into the sounds. Is particularly numerous in eel-grass.

ISOPODA.

Sphaeroma quadridentata, Say.

Called "Pill bug" by residents; and is common on the rocky artificial breakwaters of the sea-beach.

Lidotea onca, Say.

Common on sand flats.

Of the Siphonostoma two species have been observed, one a parasite of the drum fish (*Pogonias chromis*), filiform, with a stellate head, the other oval in shape, and attached to the sting-ray (*Trygon centrura*).

CIRRIPEDIA.

Balanus galeatus, Darwin.

Common on *Leptogorgia virgulata*.

Balanus oburneus, Gould.

Common.

Balanus balanoides, Stimpson.

Abundant on stakes and piles of wharves.

Lepas anatifera, Linné.

The only specimens secured were found attached to pieces of wreck and drift wood, which had probably floated from far to the southward. These were living when found.

ANNELIDA.

POLYCHÆTA.

Nereis limbata, Ehlers

Is tolerably common under rocks and stones at extreme low water-mark. Is considered excellent bait for small fishes.

Diopatra cuprea, Claparède.

This beautiful and characteristic species is tolerably abundant on the muddy sand flats. A number were taken on Bird Shoal opposite Fort Macon.

Arabella opalina, Verrill (i. e. *Lumbriconereis opalina*, Verrill, in Report).

In sand at low water.

Rhynchobolus americanus, Verrill.

Collected on the flats by Dr. Yarrow.

Anthostomus robustum, Verrill.

Collected on the sand flats by Dr. Yarrow.

Sabellaria vulgaris, Verrill.

Common on shells, etc.

Cistenides Gouldii, Verrill.

A few specimens obtained by Dr. Yarrow.

Sabella microphthalmus, Verrill.

Common on piles in the interstices of ascidians, etc.

Hydroides dianthus, Verrill (= *Serpula dianthus*, Verrill, in Report).

Common on dead shells.

But little attention was devoted to the smaller crustacea and annelids, and numerous other species undoubtedly occur.

SCOLECIDA.

PHARYNGOPNEUSTA.

Balanoglossus aurantiacus, Verrill.

The original *aurantiacus* of Girard was from South Carolina (Verrill).

This species is extremely common in the vicinity of Fort Macon, and its resorts may readily be discovered, owing to peculiar coils of sand which it expels from the orifice of the holes in which it lives. These holes are lined with a coating, apparently of mucus,

MOLLUSCA.

CEPHALOPODA.

Dibranchiata.

Onmaastrophes Bartramii, Lesueur.

Two or three specimens of this comparatively rare species were found in Bogue Sound, not far from Harkers Island, having been taken in nets.

Loligo brevis, Blainville (= *L. brevicauda*, in Dr. Cones's List.)

Mr. G. W. Tryon, Jr., of Philadelphia, has identified this species from Bogue Sound, Fort Macon. A few specimens only taken.

GASTROPODA.

Pectinibranchiata.

Acis concavus (Say, sp.).

One specimen was obtained by Dr. Yarrow.

Anachis similis, Verrill.

Common on sea-beach; a few dredged on Bird Shoal at high water.

Calumbella mercatoria, Linn.

Is tolerably abundant on Bird Shoal, from which locality it was dredged.

Cerithopsis terebralis, Adams.

This species is the one alluded to by Dr. Cones in Proc. Acad. Nat. Sci., 1871, p. 141, as *Cerithium*, sp. It is not abundant.

Salma conoides, Kurtz and Stimpson

Not observed by the authors, but is given upon the authority of Kurtz and Stimpson, Proc. Bost. Soc. Nat. Hist., vol. iv., p. 115, 1851.

Strombus alatus, Gmelin.

Tolerably common on the sea-beach near Fort Macon, numerous near Cape Lookout.

Uros granulosus, Lamarck.

A single specimen was found on the beach near Cape Lookout. Is apparently uncommon.

Marginella guttata, Dillwyn.

Marginella recedens, Redfield

Both species dredged on Bird Shoal. Uncommon.

Porcellana exanthema (*Cyprina exanthema*, Linn.).

A single specimen secured.

Scalaria turbinata, Conrad.

Less abundant than *S. lineata*.

Crepidula aculeata, Gmelin.

Collected by Dr. Yarrow.

Littorina dilatata, d'Orbigny.

A few dead shells dredged on Bird Shoal. Uncommon.

Volva uniplicata, Sowerby.

A few individuals of this species were found as parasites of *Leptogorgia virgulata*, near the wharves of Beaufort, N. C.

TECTIBRANCHIATA.

Utriculus canaliculatus, Stimpson.

Abundant on Bird Shoal, numbers having been dredged there.

PTEROPODA.

Thecosomata.

Styliola acicula, Lesueur.

We are informed by Prof. Verrill that he has discovered 4 species in the cells of some sponges sent to him from Fort Ma

Glycymeris (Panopaea) bitruncata, Conrad.

A single valve only of this species was discovered by Dr. Yarrow, which Mr. Conrad deems recent, from the presence of the unaltered ligament and polish. Mr. G. W. Tryon, Jr., however, judges it to be from a submarine fossil deposit. It was found on the sea-beach six miles above Fort Macon.

Nys arenaaria, Linn.

Common in the marshy creeks near Fort Macon.

Saxicava distorta, Say.

Among ascidians, etc.

Tuttenia manhattensis, Verrill.

A few specimens found on the sea-beach. Prof. Verrill is not certain that this species is distinct from *T. gemma*, Perkins.

Chione grata (Say).

(One fresh valve.

Lucina crenulata, Conrad.

Abundant in Dr. Yarrow's collection; but perhaps not recent.

Mytilus pexata, Gray.

Common in the muddy, sandy portion of Bird Shoal, where it was dredged.

Heteromyaria.

Modiolaria lateralis (Say).

Found in the interstices of ascidians from piles.

Modiola hamatus, Verrill

Common in marshy creeks.

Perna muricata, Linn.

Abundant on sea-beach, less so, however, than *P. seminuda*.

Crasseostella undulata, Emmons (fossil).

Very abundant in the post-pliocene deposits on the main land near Fort Macon.

TUNICATA.

Saccobranchia.

Molgula pellucida, Verrill.

A few specimens of this beautiful species were dredged on Bird Shoal by Dr. Yarrow. This species has been figured by Mr. Binney, who called it *M. producta*, Stimpson, which is quite a distinct sand-covered species, and not smooth like *M. pellucida*.

Cynthia partita, Stimpson.

Very common in the sounds in the vicinity of Fort Macon.

Amarocolum stellatum, Verrill.

Very abundant on rocks and stones near Beaufort, and on the piles of the wharf at Fort Macon. The species attains a large size, and the rapidity of its growth is surprising; new clean piles used to repair a wharf were, in less than four months, well covered with large clusters of this ascidian.

POLYZOA.

The following species have been identified by Professor Verrill. Many other species doubtless occur.

Crisia eburnea, Lamx.

Small colonies were found attached to *Aglaophenia*.

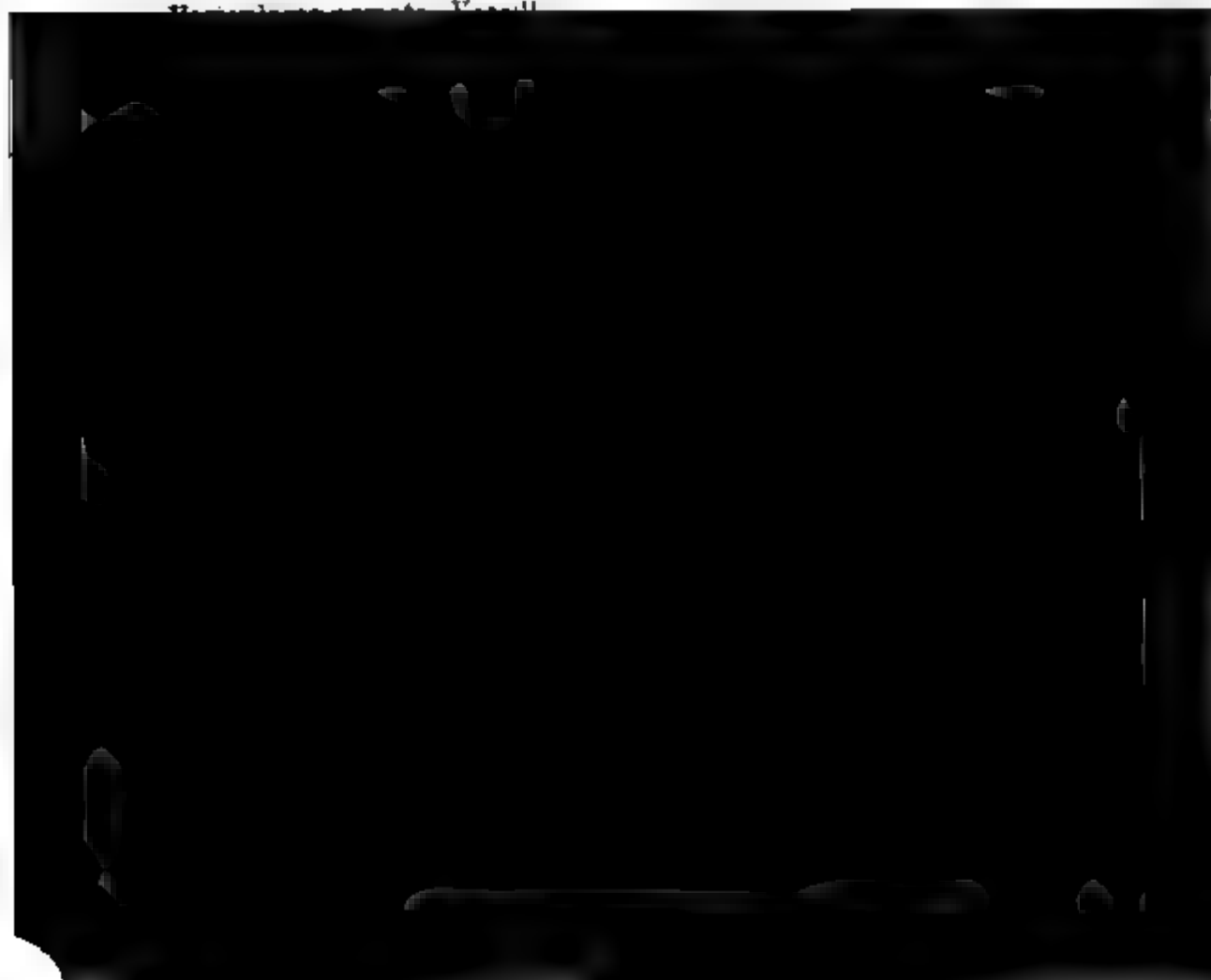
Amathia alternata, Lamx.

One fine specimen about two inches high was obtained.

Amathia, sp. undetermined

Grows in branching tufts three inches high, with the branches appearing as if twisted in a spiral, owing to the cells being arranged in a continuous spiral along one side of the branches. The spiral is more rapidly ascending than in *A. spiralis*, Lamx. (Verrill.)

Amathia alternata, Verrill.



pularia umbellata (Manz.), Smitt.

One specimen. Too much worn for accurate identification.

ustra denticulata, Smitt, Florida Bryozoa, p. 18, pl. iv. figs. 89-91.

Common on shells.

pythoe hyalina, Smitt.

Common on algæ, etc.

Maperta, Smitt, Florida Bryozoa.

Several specimens on dead shells, one with the oœciæ.

variabilis, Verrill (*Escharella variabilis*, V., in Report).

Is tolerably common as calcareous incrustations on shells, etc.
thickened masses much resembles true coral.

Ulepora avicularis, Hincks.

One cylindrical colony attached to the stem of *Aglaophenia*,
others on algæ, etc.

pralla Americana, Verrill.

On dead shells; not uncommon.

Ulepora nitida, Verrill.

Common on dead shells.

RADIATA.

The following list contains all the species that have been identified up to this time:—

ECHINODERMATA.

Holothurioidea.

Urechis caupo, Selenka.

An extremely abundant and characteristic species, great numbers being found among masses of sea-weed on the beach near Mt Macon. Many hundreds have been noticed during a walk of less than a mile, particularly after an easterly storm. This species is noticeable and remarkable for a peculiar habit it possesses of turning the entire viscera if exposed long to the rays of the sun, kept for a length of time in the collector's basket.

Urechis pulcherrima, Ayres.

Lighter in color than the preceding species, and has the ambulatory suckers arranged in five bands. Numerous on sea-beach after storms.

Thyonella gemmata, Verrill.

Tolerably abundant.

A walk of a few miles up the sea-beach at Fort Macon, after an easterly blow, will reveal to the observer a number of pinkish translucent formless lumps of semi-cartilaginous appearance; these masses, varying in coloration from light pink to vivid red, are occasionally met with of a light blue or green tint. This undetermined organism is, perhaps, the one named above. Placed in a salt-water vivarium after a short time the tentacles begin to be extended, resembling clusters of the most beautiful algæ. The entire surface of the animal is covered at intervals with indented specks, darker than the surrounding tissue, these are probably analogous to the warts of *Synapta tenuis*, Ayers (*Leptosynapta Girardii*, Verrill).

! *Leptosynapta Girardii*, Verrill.

We find in our notes taken in June, 1871, this species as having been identified, with the following remarks: "This curious holothurian is particularly noticeable on account of its transparency. They are found at low-water in the sandy marshes abundantly." As Prof. Verrill considers it a northern form, we prefer to mark it as doubtful.

Echinoidea.

Arbacia punctulata, Gray (*Echinocidaris punctulatus*, in Cones's List).

Tolerably abundant on sea beach and inlet beach after storms. It has long stout purple spines, and the anal region is composed of four large plates

Astropecten articulatus (Say), Lütken.

Common.

Lidia elathrata (Say), Lütken.

Not uncommon on sandy bottoms.

Ophiuroidea.

Ophiura olivacea, Lyman.

Very numerous on shoals in Beaufort Harbor.

Ophiophragmus Wurdemanii, Lyman. Verrill, Amer. Journ. Sci. and Arts, vol. ii. p. 123, 1871.

Common in sand at low water. Dr. Cones.

Ophiethrix angulata, Ayres.

"Common in the cavities of sponges." (Verrill.)

ACALEPHÆ.

Discophoræ.

Pelagia cyanella, Peron and Lesueur.

Occasionally found in the inlet creeks.

HYDROIDÆ.

Thecaphora.

Campanularia carolinensis, Verrill, sp. nov.

A small species, creeping over the stems of *Aglaophenia*, remarkable for the unusually large goblet-shaped hydrothecæ, which are supported on short and slender pedicles. Root-stalks slender, translucent, wrinkled, but not regularly annulated, giving off at short intervals the slender pedicles which are shorter than the cups, mostly having only four or five somewhat irregular and imperfect oblique annulations. Hydrothecæ deep cup-shaped or goblet-shaped, with a smooth, thin, slightly everted rim. These cups are nearly twice as deep as wide, and about twice as long as the pedicles. They taper toward the narrow base with a gradual curvature; the basal portion is considerably thickened internally, with a small septum very near the bottom. Gonothecæ unknown.

Height of hydrothecæ, 1 mm.; diameter, .60 mm.; length of pedicles, .45 mm.

Collected by Dr. Yarrow.

Owing to the absence of gonothecæ the reference of this species to *Campanularia* is only provisional. (A. E. V.)

Lafoea calcarata, A. Agassiz

Found creeping over *Sertularia cornicina*.

Sertularia (*Desmoscyphus*) *Achilles*, Verrill, sp. nov.

Stem alternately pinnate, articulated, each segment bearing first a branch, and then about three hydrothecæ arranged alternately; branches somewhat elongated, simple on our specimen, distinctly articulated near the base, below the first hydrotheca; beyond this the articulations are rather indistinct and irregular; the internodes usually appearing to bear two, three, or more pairs of opposite secund hydrothecæ, which are adnate to the branch and to each other, and so placed on the upper side of the branch as to have both their apertures turned upward and outward; the hydrothecæ are stout, swollen in the middle, with the upper free portion bent abruptly outward, nearly at a right angle, and tapering rapidly to the aperture, which is distinctly bilobed, the lobes rounded. The intervals between the hydrothecæ about equal them in length. On the main stem the hydrothecæ have nearly the same form, but are alternate and distant from each other, though still somewhat secund.

Height of the specimen (probably young), 33 mm.; length of longest branches, 5 mm. Gonothecæ unknown.

This peculiar species would belong to the genus *Desmoscyphus*, of Allman, but it unites that group still more closely to the true *Sertulariæ*. Collected by Dr. Yarrow. (A. E. V.)

Athecata.

Margolis carolinensis, Agassiz.

This beautiful and delicate jelly-fish is tolerably abundant.

Eudendrium tenue, A. Agassiz. ?

A single female colony was found on *Cynthia partita*. This species has rather slender, much branched, simple, light yellowish brown stems, rather irregularly annulated throughout. The branches diverge widely at first, and then bend upward and are more or less crooked. The female gonophores are pedicelled, and form thick clusters around the blastostyles. (A. E. V.)

Porypha cresea, Agassiz.

This species is considered by Prof. Verrill to be probably not distinct from *P. cristata*, Agassiz. It is quite common near Fort Macon.

Hydractinia polyclina, Agassiz.

Common at Fort Macon in clusters on stones and shells.

Porpitæ.

Physalia pelagica, Lamarek.

Dr. Cones in a former paper (Proc. Acad. Nat. Sci. 1871, p. 148) mentions the occurrence of a *Physalia* in the locality under discussion, which has been since recognized as *P. pelagica*. In March, 1871, large numbers were noticed in and beyond the surf on the sea-beach after a severe storm from the southward. A number of specimens were secured, among them one which had a small dead fish entangled in its long tentacular hydroid appendages. Most of those upon the beach were dead, and could be handled with impunity, but when living the stinging produced by touching the hydroid tentacles is very apparent and painful. Dr. Brown on one occasion was consulted by a fisherman, who, seeing the animal floating on the water, reached out and grasped it, and paid dearly for his temerity, as when seen the entire arm to the shoulder was very red, much swollen, and exquisitely painful. The irritation lasted several days, and was allayed by a saturated solution of bi-carbonate of soda. The *Physalia* may be handled without danger if seized by the corrugated crest of the bladder-like portion. It is supposed by many that this animal is a virtual poison, and that fish eating it also become poisonous. Mons.

P. Labat in his *Book of Voyages* mentions that several persons eating of a fish that devours the *Physalia* became dangerously ill, but this sickness may have been produced by other causes. However this may be, Dr. Yarrow saw a case in which a small terrier dog died in a very short time after eating a piece of the hydroids of this species. Upon making a post-mortem the stomach was found entirely empty) with the exception of the piece of the animal eaten) and greatly congested. Mons. Ricord Madiara made a series of experiments to test the poisonous qualities of *Physalia*, and arrived at the conclusion that it is not poisonous apart from the stinging property. Specimens secured at Fort Macon were about six inches wide on the bladder portion, with hydroids five or six feet long. They were of a beautifully iridescent purplish color.

Porpita, sp.

A single specimen of this genus was found stranded on the seabeach, which Prof. A. Agassiz informs us was possibly *P. pacifica*, or *P. Linnaeana*, of Lesson, but, unlike the latter, the hydroid appendages were bright yellow in color.

Vellela mutica, Lamarck.

Occasionally noticed.

POLYPI or ANTHOZOA.

Alcyonaria

within sounds and inlets, but more were seen on or near the sea-beach.

Leptogorgia virgulata, Milne Edwards.

Quite common in same localities, with preceding species. Varies exceedingly in color.

Anthopodium rubens, Verrill. Am. Journ. Sci., iii. 1872, p. 435.

This interesting new species was discovered by Prof. Edw. S. Morse at Fort Macon, encrusting the dead axis of *Leptogorgia*. Color light red. Is not common.

Stenidreum suberosum, Verrill.

Was first discovered in North Carolina by the lamented Stimpson. Is abundant.

Talaster fructiculosus, Dana.

Common near Beaufort, N. C.

Actinaria.

Sagartia leucolea, Verrill.

Abundant; found attached to the under sides of rocks and stones.

Paractis rapiformis, Milne Edwards.

This curious species, called *Actinia rapiformis* by Lesueur, was first taken in New Jersey, in 1817, after which time it was long out of sight of, was discovered by Dr. Yarrow on the sea-beach at Fort Macon, where it occurred in great numbers after a hard north-east gale. It then resembles a water-soaked peeled pear or onion, with whitish striae. Very abundant.

Alcanta producta (Stimpson MSS.), Verrill.

Tolerably common in sandy and muddy places inside of Beaufort, living beneath the surface with the tentacles extruded. Undisturbed. Is capable of great expansion and contraction. Some specimens seen were twelve inches in length.

Alcanta sol, Verrill.

Very numerous at Fort Macon; found adhering to eel-grass, and to shells occupied by the hermit crab (*Eupagurus*). Is one of the most beautiful of the anemones of the locality.

Alcanta capitata, Verrill.

A very common species.

Cladactis cavernata, Verrill.

Common on rocky breakwaters of sea-beach. It is so firmly attached that considerable force is required to dislodge it.

Cerianthus americanus, Verrill.

Abundant in muddy marshes.

Elyanthus chloropsis (Agassiz MSS.), Verrill.

Although Prof. Verrill states in his paper (*Rev. Polyps. East Coast, U. S.*, 1864) that this species is thought to be very rare, it is believed to have been discovered by the authors at Fort Mason as at least two dozen individuals answering the description in the paper quoted were taken on the sea-beach after severe storms from the northward.

Paranthes pallida, Verrill.

It is believed this species has been recognized, a few specimens having been collected on the sea-beach in the summer of 1871.

Some few specimens of an undetermined species were taken on the beach after a severe gale. May be readily recognized by the six white radiating lines across the disc from the mouth.

Madreporaria.

Astrangia Dana, Agassiz.

Common on sea-beach after storms.

Oculina arbuscula, Verrill.



KERATOSA.

Hircina campana, Nardo.

One specimen, collected by Dr. Yarrow.

Spongia vermiculata, var. *vermiculatiformis*, Hyatt.

This interesting form is not uncommon; several large specimens, both dry and in alcohol, having been collected by Dr. Yarrow.

Spongella dubia, var. *foraminosa*, Hyatt.

Collected by Dr. Yarrow.

Spongella spinosa, Hyatt.

One or two specimens obtained by Dr. Yarrow.

Dysidea fragilis, Johnston (?)

Specimens, referred doubtfully to this species by Prof. Hyatt, are in the collection.

It is greatly to be regretted that the identifications of many of the sponges forwarded from Fort Macon have not been made.

INSECTS.

It might be supposed from the paucity of vegetation near Fort Macon that this class would be but poorly represented, such is not the case, as during the sojourn of the authors of this paper at that place hundreds of different specimens were collected and forwarded to competent specialists for examination. Unfortunately, names only for the Coleoptera and Orthoptera have been received, for the former from Dr. G. W. Horn, of Philadelphia, for the latter from Dr. P. R. Uhler, of Baltimore, to whom our hearty thanks are due for their favors. We regret particularly being unable to furnish the names of more of the Lepidoptera, as the collection was large, being particularly rich in moths.

COLEOPTERA.

Of the following species, all are more or less common in the vicinity of Fort Macon:—

Tetracha virginica, Linn.

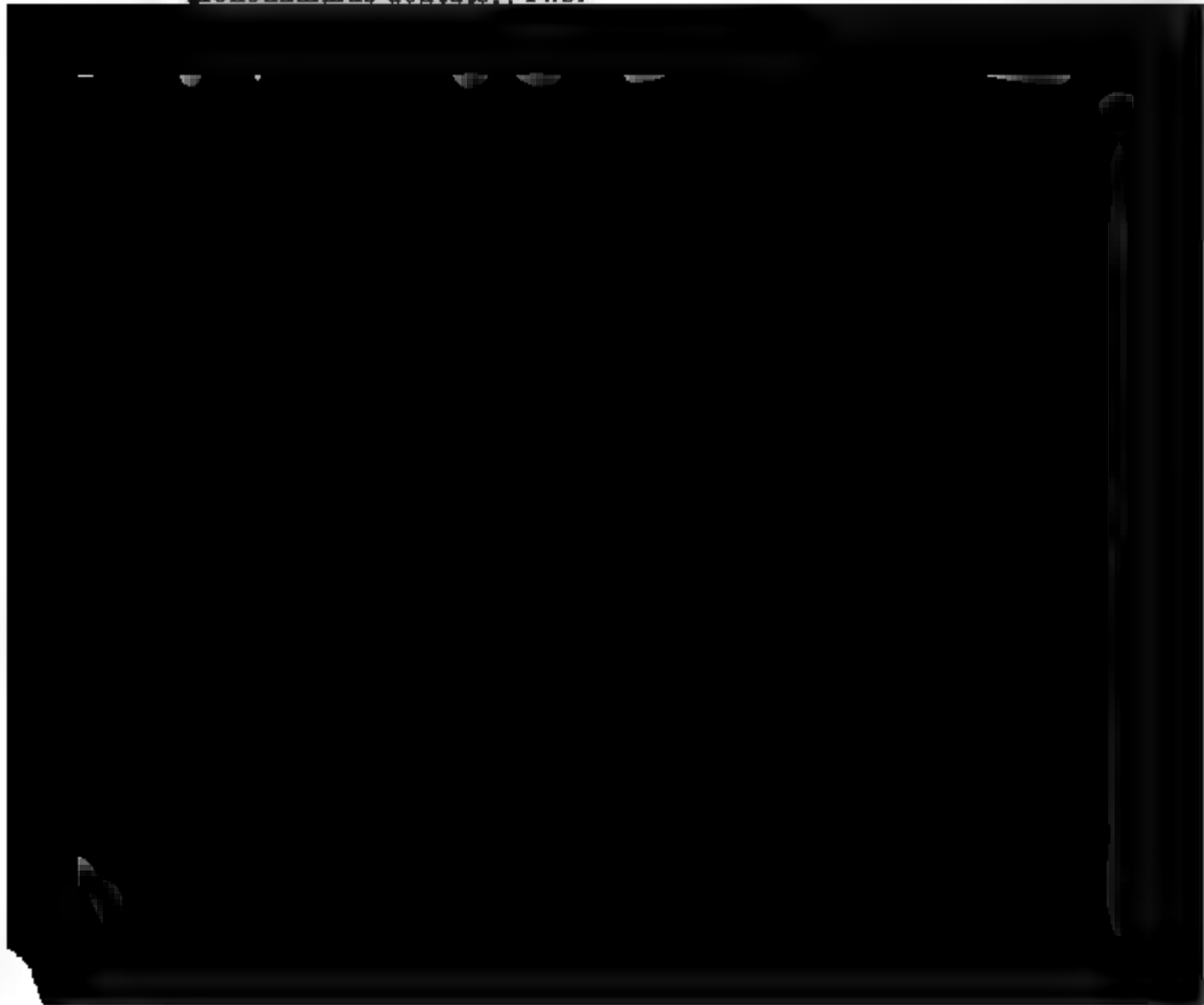
Stenodonta punctulata, Fab.

Disceus purpuratus, Bon.

Harpalus compar, Lec.

Harpalus pennsylvanicus, Lec.

Harpalus stigmosis, H'bst.
Harpalus caliginosus, Say.
Anisodactylus mysticus, De Geer.
Staphylinus maculosus, Grav.
Trox punctatus, Fab.
Canthon laevis, Fab.
Canthon chalcitae, Hald.
Euryomia sepulchratus, Lac.
Allorhina nitida, Lac.
Cyclocephala immaculata, Burm.
Nigynus gibbosa, De Geer.
Passalus cornutus, Fab.
Corynetis rufipes, Fab.
Chalcophora virginica, Linn.
Alaus myops, Esch.
Alaus oculatus, Esch.
Chauliognathus marginatus, Hy.
Collops eximius, Er.
Macendes melanura, Fab.
Oxacia dorsalis, Say.
Meloidon dasytemus, Hald.
Prionus laevigatus, Harris.
Clytus caprea, Say.
Leptura nidens, Forst.
Monochammus dentator, Fab.



mericanum, Drury.

otusum, Burm.

er, Sew.

lemur-rubrum, De Geer.

s maculipennis, Scudd.

vitata, Lew.

HYMENOPTERA.

n. Linn.

lipes, Lacip.

LEPIDOPTERA.

rias, Drury.

dice, Godart.

olina?

named species is very rare, but two individuals having

lla, Drury.

numerous in July and August.

orcea, Drury.

DIPTERA.

sola, Fab.

atus, Fab.

stica, Linn.

;, Linn.

loria, Linn.

preceding species of Diptera are much too common for
Fort Macon.

ion to the list of Insects, others of the following genera
found:—

sp.

within a reasonable period, further determination of
are received, this paper may be considered as the con-
ne of the series.

Harpalus stigmosea, H'bst.
Harpalus caliginosus, Say.
Anisodactylus mysticus, De Geer.
Staphylinus maculosus, Grav.
Trox punctatus, Fab.
Canthon laevis, Fab.
Canthon chalcitae, Hald.
Euryomia sepulchratas, Lac.
Allorhina nitida, Lac.
Cyclocephala immaculata, Burm.
Sigynus gibbosa, De Geer.
Passalus cornutus, Fab.
Corynetes rufipes, Fab.
Chalcophora virginica, Linn.
Alaus myops, Esch.
Alaus oculatus, Esch.
Chaulognathus marginatus, Hy.
Collops eximius, Er.
Macendes melanura, Fab.
Oxalis dorsalis, Say.
Meloidon dasytemus, Hald.
Prionus laevigatus, Harris.
Olytus caprea, Say.
Leptura nidens, Forst.
Monochamus dentator, Fab.
Hylotrupes sagalus, Fab.
Elaptendion atomarium, De Geer.
Chrysomela, Esch.

Parthenopidæ.

***Heterocrypta granulata*, Stimpson.**

Cryptopodia granulata, Gibbes, l. c., p. 173 ; *ibid.*, Proceedings of the Elliot Society of Charleston, S. C., June, 1856, i. p. 35 (wood-cut).
Stimpson, Ann. Lyc., vii. p. 202.

Heterocrypta granulata, Stimpson, Annals Lyc., 1870, x. p. 102.

Beaufort, N. C. (Stimpson), to the West Indies.

CANCROIDEA.**Canoridæ.**

***Cancer irroratus*, Say.**

Cancer irroratus, Say, l. c., i. p. 59, pl. iv. f. 2. Stimp. Ann. Lyc. vii. p. 50. Smith, Fish Comm. p. 546. Coues, l. c., p. 120.

Platycarcinus irroratus, M. Edw., op. cit., i., p. 414.

Cancer sayi, Gould, op. cit., p. 323.

Platycarcinus sayi, Dekay, op. cit., p. 7, pl. ii. f. 2. Gibbes, Proc. American Asso. iii. p. 177.

Cancer borealis, Packard, Memoirs Boston Society of Natural History, 1867, i. p. 303.

Labrador to South Carolina ; Fort Macon (Coues).

***Cancer borealis*, Stimpson.**

Cancer irroratus, ♀ Say, Journal of the Academy of Natural Sciences, Philadelphia, 1818, vol. i. p. 59.

Cancer irroratus, Gould, Invertebrata of Massachusetts, 1841, p. 322.

Platycarcinus irroratus, Dekay, N. Y. Fauna, Crustacea, 1842, pl. 6.

Cancer borealis, Stimpson, Annals Lyceum Nat. Hist. N. Y., 1860, vii. p. 50. Smith, Report U. S. Fish Commission for 1871-2, p. 546.

A young specimen of this well-marked and valid species occurs in the collection made at Fort Macon, N. C., by Dr. A. S. Packard, Jr., and I am informed by Mr. Faxon that there are specimens in the Museum of Comparative Zoology, at Cambridge, from the Bermudas.

It is readily separated from the common *Cancer irroratus*, Say, by the granulated carapax and the crenulated antero-lateral teeth. This species was described by Say (*l. c.*) as the female of his *C. irroratus*. But it was first pointed out by Dr. Gould that it was a distinct species. He, however, thought proper to retain the name for this species, rather than the more common form, which he regarded as the male.

It ranges from Nova Scotia to the West Indies.

***Menippe mercenaria*, Stimpson.**

Cancer mercenaria, Say, l. c., 1818, i. p. 448.

Cancer (Xantho) mercenaria, H. Milne Edwards, Histoire Naturelle des Crustacés, 1834, vol. i. p. 399.

?*Pseudocarcinus ocellatus*, Edw., op. cit., 1834, i. p. 409.

Pseudocarcinus mercenaria, Gibbs, Proceedings American Association for the Advancement of Science, 1851, iii. p. 176.

Menippe mercenaria, Stimpson, Annals N. Y. Lyceum, 1839, vii. p. 525 (in text). Streets, Proceedings of the Academy of Natural Sciences, Philadelphia, 1871, p. 239. Coues, l. c., p. 120.

North Carolina to Florida. Dr. Streets (l. c.) reports it from the Isthmus of Panama. Fort Macon (Packard).

It is readily separated from the only other species of *Menippe* (*M. rumphii*, De Haan, Stimpson, Annals N. Y. Lyceum, 1871, x. p. 107) found on this coast, by the sharp edges of the teeth on the antero-lateral margin.

Dr. Coues sent the dactylus of the cheliped of an enormous example to the Peabody Academy. It measured three inches in length.

***Panopeus herbstii*, Edwards.**

Cancer panope, Herbst, Naturgeschichte der Krabben und Krebs, pl. 54, f. 5. Say, l. c., 1818, i. p. 58, pl. iv. f. 6.

Panopeus herbstii, Edw., op. cit., i. p. 403. Dekay, op. cit., p. 5, pl. 32, f. 26. Gibbs, l. c., iii. p. 176. Heller, Reise der Novara, p. 76. Smith, Proceedings of the Boston Society of Natural History 1843, xii. p. 276. Ibid., Transactions of the Connecticut Academy, 1872, p. 719.

Panopeus depressus, Smith.

Panopeus depressus, Smith, Proc. Bost. Soc. xii. p. 283; *ibid.*, Fish Comm., p. 547, pl. i. f. 3.

Massachusetts Bay to Florida.

Panopeus sayi, Smith.

Panopeus sayi, Smith, Proc. Bost. Soc., xii. p. 284; *ibid.*, Rep. U. S. Fish Comm., p. 547.

Massachusetts to Florida.

Panopeus harrisi, Stm.

Panopeus harrisi, Gould, op. cit., p. 326. Dekay, op. cit., p. 7, pl. vii. f. 15.

Panopeus harrisi, Stimpson, Ann. Lyc., vii. p. 55. Smith, Fish Comm., p. 547.

Massachusetts Bay to Florida.

The various species of North American *Panopei* are well separated by Prof. Smith in the paper referred to in the Proceedings of the Boston Society.

Portunus limosus, Stm.

Portunus limosus, Say, l. c., p. 446.

Panopeus limosus, Edwards, op. cit., i. p. 404. Dekay, op. cit., p. 5. Gibbes, l. c., p. 176.

Portunus limosus, Stm., Ann. Lyc., vii. p. 50.

New York to Florida.

Eriphidæ.

Portunus aculeatus, M. Edw.

Portunus aculeatus, Say, l. c., i. p. 449.

Portunus aculeatus, M. Edw., op. cit., i. p. 420. Dekay, op. cit., p. 5. Gibbes, l. c., p. 177. Stimpson, Bulletin of the Museum of Comparative Zoology, 1871, ii. p. 141. Coues, l. c., p. 120.

from Macon (Coues) to Florida.

Portunidæ.

Portunus sayi, Stimp.

Portunus pelagicus, Say, l. c., p. 97. Dekay, op. cit., p. 11, pl. vi. f. 8 (non Leach).

Portunus sayi, Gibbes, l. c., p. 178. Dana, Crustacea U. S. Exploring Expedition, 1852, p. 273, pl. xvi. f. 8. Stimpson, Proceedings Acad. Nat. Sci., Philadelphia, 1858, p. 38.

Portunus sayi, Stimpson Ann. Lyc., vii. p. 220; *ibid.*, Bulletin M. C. Z., li. p. 147. A. Milne Edwards, Archives du Museum d'Histoire Naturelle, 1861, t. x. p. 317, pl. xxix. f. 2.

New York to Florida.

***Callinectes hastatus*, Ordway.**

Lupa hastata, Say, l. c., 1818, i. p. 65.

Lupa diacantha, Dekay, op. cit., 1842, p. 10, pl. III. f. 3.

Callinectes hastatus, Ordway, Journal Boston Society, vii. p. 568.

Smith, Rep. U. S. Fish Comm. 1871, 2, p. 548. Coues, l. c., p. 120.

This species which, at the time of moulting, furnishes the well-known soft shell crab, is found from Salem, Mass., to Florida and Alabama. It is, however, rare north of Cape Cod. Several specimens brought by Dr. Packard from Fort Macon.

***Aranus cribrarius*, Dana.**

Portunus cribrarius, Lamarck, Animaux sans Vertebres, v. p. 359 (teste M. Edwards).

Lupa maculata, Say, l. c., p. 445. Dekay, op. cit., p. 11.

Lupa cribraria, Edw. Crustacés, i. p. 452, pl. xviii. f. 1. Gibbs, l. c., p. 178.

Aranus cribrarius, Dana, U. S. Exploring Exped. Crustacea, p. 290, pl. xviii., f. 2. Smith, Transactions Connecticut Acad., ii. p. 85; 3d Report Peabody Academy of Science, 1871, p. 91. Coues, l. c., p. 121.

Neptunus cribrarius, A. M. Edw., Arch. Mus. d'Hist. Nat. 1861, t. x. p. 324.

New Jersey to Aspinwall and Brazil; Fort Macon (Coues and Packard).

***Achelous spinimanus*, De Haan.**

Portunus spinimanus, Latreille, Encyclopedie Methodique, x. p. 188 (teste Edwards).

Lupa spinimana, Leach. Desmarest Considerations sur les Crustacés, 1825, p. 98. Edw., op. cit., i. p. 452. Dana, U. S. Ex. Ex., Crust.

l. p. 273. Shumacher, Ann. Lye. Nat. h. 57.

Achelous depressifrons, Stimpson, l. c., vii. p. 223. Alph. M. Edw., l. c. x. p. 342. Coues, l. c., p. 121.

Fort Macon (Coues) to Florida.

Platyonichidæ.

Carcinus maenas, Leach.

Cancer maenas, Pennant, British Zoology, iv. p. 3. pl. iii. f. 5 (teste Bell).

Portunus maenas, Leach, Edinburg Encyclopedia, vii. p. 390 (teste Bell).

Carcinus maenas, Leach, l. c., p. 429; ibid., Trans. Linnean Society of London, xi. p. 314; ibid., Malacostraca Podophthalmia Britannicæ, pl. v. fs. 1-4. M. Edw., op. cit. i. p. 434. Gould, op. cit., p. 321. DeKay, op. cit., p. 8. pl. v. fs. 5-6. Bell, British Stalk-eyed Crustacea, 1853, p. 76. Streets, Bulletin U. S. National Museum No. 7, 1877, p. 109. Kingsley, Bulletin Hayden's Survey, 1878, iv. p. 191.

Cancer granulatus, Say, l. c., 1817. i. p. 61.

Carcinus granulatus, Smith, Fish Comm. p. 547.

This species is almost cosmopolitan in its range. It is found on the Eastern Coast of the U. S., from Cape Cod to New Jersey, at Panama, in the Hawaiian Islands, France and England, in the Baltic and Mediterranean, the Red Sea, Brazil, and, doubtfully, in Australia.

Platyonichus ocellatus, Latreille.

Cancer ocellatus, Herbst, Naturgeschichte der Krabben und Krebse, p. 61. pl. xlix. f. 4.

Platyonichus pictus Say, l. c., i. p. 62, pl. iv. f. 4.

Platyonichus ocellatus, Latreille, Encyc. Method., xvi. p. 152. Edw., op. cit. i. p. 437. DeKay, op. cit., p. 9, pl. i. f. 1. pl. v. f. 7. Gibbs, l. c., p. 177. A. Milne Edwards, l. c., x. p. 415, pl. xxxvi. f. 4. Smith, Fish Comm., p. 547, pl. i. f. 1. Coues, l. c., p. 120.

New Bedford, Mass., to Florida; Fort Macon (Coues).

OCYPODOIDEA.

Ocypodidæ.

Golenismus minax, Le Conte.

Golenismus minax, Le Conte, Proceedings Acad. Nat. Sci., Philadelphia, 1855, p. 403. Smith, Trans. Conn. Acad., ii. p. 128, pl. ii. f. 1. pl. iv. f. 1-1 b. Ibid., Fish Commission, p. 545. Coues, l. c., 121.

Golenismus palustris (pars), Stimpson, Ann. Lyc., vii. p. 62.

New Haven to Florida; Fort Macon (Coues).

Gelasimus pugnaz, Smith.

Gelasimus vocans (pars), Gould, op. cit., p. 325.

Gelasimus vocans, var. *A.*, DeKay, op. cit., p. 14, pl. vi. f. 10 (non *Cancer vocans*, L.)

Gelasimus pugillator, Le Conte, l. c., p. 408 (non Bosc.).

Gelasimus palustris, (pars), Stimpson, l. c., vii. p. 62 (non Milne Edwards).

Gelasimus pugnaz, Smith, Trans. Conn. Acad., ii. p. 181, pl. ii. f. 1, pl. iv. f. 2. Ibid., Fish Commission, p. 545. Coues, l. c. p. 121.

Cape Cod to Florida, the West Indies, and the Gulf of Mexico; Fort Macon (Coues).

Gelasimus pugillator, Latreille.

Ocypoda pugillator, Bosc, Histoire Naturelle des Crustacés, i. p. 197.

Ocypoda pugillator (pars), Say, l. c. i. pp. 71 and 443.

Gelasimus pugillator, Latreille, Nouv. Dictionnaire d'Histoire Naturelle, 2me Edition, t. xii. p. 250. Desmarest, Considerationes sur les Crustacés, p. 123. II. Milne Edwards, Annales des Sciences Naturelles, Zoologie, t. xviii. p. 14, pl. iv. f. 149. Stimpson, Ann. Lyc., vii. p. 62. Smith, Trans. Conn. Acad., ii. p. 186, pl. iv. f. 7. Ibid., Fish Comm., p. 545. Coues, l. c., p. 121.

Gelasimus vocans (pars), Gould, op. cit., p. 325.

Gelasimus vocans, DeKay, op. cit., p. 14, pl. vi. f. 9.

Cape Cod to the West Coast of Florida; Fort Macon (Coues).

Ocypoda arenaria, Say.

Cancer arenarius, Catesby's Carolina, ii. pl. 35 (teste Say, Edwards).

Ocypoda arenaria, Say, Journal Academy of Natural Sciences, Philadelphia, 1817, i. p. 69. H. Milne Edwards, Hist. Nat. des Crust., ii. p. 44, pl. xix. f. 18-14. DeKay, op. cit., p. 18. Gibbs, l. c., p. 180. Smith, Rep. U. S. Fish Commission, p. 545. Coues, l. c., p. 122.

Grapelidæ.***Squilla reticulata*, Say.**

Squilla reticulata, Say, l. c. i. pp. 73, 76, and 442, pl. iv. f. 6. Gibbs, l. c. p. 180. Edw., Ann. Sci. Nat., III. xx. p. 182. Stimpson, Annals N. Y. Lyc., vii. p. 66. Smith. Trans. Conn. Acad., ii. p. 156. Ibid., U. S. Fish Commission, p. 546. Coues, l. c., p. 121.

Squilla reticulata, Dekay, op. cit., p. 15.

Long Island Sound to Florida; Fort Macon (Coues, Packard).

***Squilla cinerea*, Say.**

Libinia cinerea, Bosc, Histoire Naturelle des Crustacés, i. p. 204, pl. v. f. 1.

Squilla cinerea, Say, l. c., i. p. 442. Edwards, op. cit., ii. p. 75. Ibid., Annales des Sciences Naturelles, II^{me} Serie, Zoologie, t. xx. p. 182. Gibbs, l. c., p. 180. Stimpson, Annals N. Y. Lyceum, vii. p. 65. Smith, Transactions Connecticut Academy, ii. p. 157. Coues, l. c., p. 121.

Virginia to Florida; Fort Macon (Coues).

Pinnotheridæ.***Pinnotheres ostreum*, Say.**

Pinnotheres ostreum, Say, l. c., i. p. 67, pl. iv. f. 5. Gould, Invert. Mass., p. 328. Dekay, op. cit., p. 12, pl. vii. f. 16. Gibbs, l. c., p. 179. Stimpson, Annals N. Y. Lyceum, vii. p. 67. Coues l. c., p. 123. Smith, Fish Comm., p. 546.

Salem, Mass. (in transplanted oysters), to South Carolina; Fort Macon (Coues).

***Pinnotheres maculatus*, Say.**

Pinnotheres maculatus, Say, l. c., i. p. 450. Dekay, op. cit., p. 13. Gibbs, l. c., p. 179. Stimpson, Ann. N. Y. Lyceum, vii. p. 67. Smith, Fish Comm., p. 546.

Pinnotheres ostreum, 3 Smith, Fish Comm., pl. i. f. 2.

Canal from Coal to South Carolina; Fort Macon, Stimpson.

(The following species of *Pinnotheres* may possibly be found at Fort Macon. They were described by Say, but so far as I am aware they have not been observed by other carcinologists:—

P. depressum, from New Jersey.

P. pygmaea, "Southern coast."

P. maculidactylum, no locality.

***Pinnotheres sayana*, Stimpson.**

Pinnotheres sayana, Stimpson, Annals N. Y. Lyceum, vii. p. 236.

Fort Macon (Stimpson).

***Pinnixa cylindrica*, White.**

Pinnothares cylindricum, Say, l. c., p. 453. Dekay, op. cit., p. 12.

Pinnixa cylindrica, White, List Crustacea in the British Museum, 1861, p. 33. Ibid., Annals and Magazine of Natural History, 1844, Foreign Series, xviii. p. 177. Stimpson, Annals N. Y. Lyceum, vii. p. 63. Smith, U. S. Fish Commission, p. 546, pl. i. f. 1.

Pinnixa laevigata, Stimpson, Annals N. Y. Lyc., vii. p. 63.

Long Island Sound to South Carolina.

***Pinnixa chætopterana*, Stimpson.**

Pinnixa cylindrica, Stimpson, Annals N. Y. Lyceum, vii. p. 63 (as White).

Pinnixa chætopterana, Stimpson, l. c., vii. p. 235.

Charleston, S. C. (Stimpson). A single male occurred in the collections made by Dr. Packard at Fort Macon.

LEUCOSOIDEA.**Calappidae.*****Calappa marmorata*, Fabr.**

Cancer marmoratus, Fabr.; Ent. Syst., ii. p. 450.

Cancer flammeus, Herbst, op. cit., ii. p. 161, pl. xi. f. 2.

Calappa marmorata, Fabr., Sup. Ent. Syst., p. 346. Edw., Hist. Crust., ii. p. 104. Gibbs, l. c., p. 183. Stm., Ann. Lyc., vii. p. 63. Ibid., Am. Journ. Sci. and Arts, II. xxix. p. 444. Ibid., Bol. Mus. Comp. Zool., ii. p. 153.

Fort Macon (Stimpson) to the West Indies.

Peræphona Lamarckii, Leach, Zool. Misc., iii. p. 23 (teste Bell).

Gnathia punctata, Edw., Hist. Nat. des Crust., ii. p. 127. Gibbes, Proc. Ann. Assoc. iii. p. 185.

Peræphone gnathia, Bell, Transactions Linnean Society, London, xxi. p. 292. Ibid., Catalogue Crustacea in British Museum, pt. i. Leucosia-læ, 1855, p. 10.

Peræphone punctata, Stimpson, Annals N. Y. Lyceum, vii., p. 70. Coues, l. c., p. 123.

Fort Macon, N. C. (Coues), to Florida and the West Indies.

Lithadia cariosa, Stim.

Lithadia cariosa, Stimpson, Ann. N. Y. Lyc. vii. p. 238.

Fort Macon (Stimpson).

RANINOIDEA.

Raninidæ.

Ranilia muricata, Edw.

Ranilia muricata, H. Milne Edwards, Hist. Nat. des Crustacés, ii. p. 195. Gibbes, Proc. Am. Assoc. Adv. Sci., iii. p. 187. Ibid., Proceedings of the Elliot Society of Charlestown, S. C., i. p. 225, pl. xiii. (1857).

North Carolina to Florida.

PORCELLANOIDEA.

Porcellanidæ.

Porcellana ocellata, Gibbes.

Porcellana ocellata, Gibbes, Proc. Am. Assoc., iii. p. 190. Ibid., Proc. Elliot Soc., i. p. 12, pl. i. f. 2. Stim., Proc. Phila. Acad., 1858, p. 229. Ibid., Ann. Lyc., vii. p. 77. Ibid., Am. Journ., II. xxix. p. 444.

Fort Macon (Stimpson) to the West Indies.

Porcellana sociata, Say.

Porcellana sociata, Say, l. c., i. p. 456. Edw., Hist. Nat. Crust., ii. p. 238. Gibbes, Proc. Am. Assoc., iii. p. 190. Ibid., Proc. Elliot Soc., i. p. 12, pl. i. f. 6. Stimpson, Proc. Phila. Acad., 1858, p. 229. Ibid., Am. Journ. II. xxix. p. 444.

Pandia sociata, Leach, Desmarest.

Fort Macon (Stimpson) to Florida.

In Say's description the specific name of this species was spelled *ociata*, probably a typographical error.

Eucromus praelongus, Stim.

Eucromus praelongus, Stim., Am. Journ. Sci. and Arts, II. xxix. p. 445.

Fort Macon (Stimpson).

HIPPOIDEA.**Hippidae.****Hippa talpoida**, Say.

Hippa talpoida, Say, l. c., l. p. 160. Stimpson, Proc. Acad. Nat. Sciences, Philadelphia, 1858, p. 280. Coues, l. c., p. 124. Smith, U. S. Fish Commission, p. 548, pl. ii. f. 5. Ibid., Trans. Conn. Acad., iii. pp. 311-342, pls. xlv.-xlviii. (Development).

Cape Cod to Florida; Fort Macon (Coues, Packard).

Albunidae.**Lepidops scutellata**, Stm.

Albunea scutellata, Desmarest, Consid. Crust., p. 173. Edw., Hist. Nat. Crust., ii. p. 204, pl. xxi. f. 9-18. Gibbs, Proc. Am. Assoc., iii. p. 187.

Lepidops scutellata, Stm., Proc. Phila. Acad., 1858, p. 280. Ibid., Am. Journ., II. xxix. p. 444. Ibid., Ann. Lyc., vii. p. 79.

Fort Macon (Stimpson) to the West Indies.

PAGUROIDEA.**Paguridae.****Clibanarius vittatus**, Stimpson.

Pagurus vittatus, Bosc, Histoire Naturelle des Crustacés, ii. p. 8, pl. xii. Edwards, Hist. Nat. des Crust., ii. p. 237. Gibbs, Proc. Am. Assoc., iii. p. 189.

Clibanarius vittatus, Stimpson, Proc. Acad. Nat. Sci., Philadelphia, 1858, p. 285. Smith, Trans. Conn. Acad., ii. p. 16.

Fort Macon (Packard) to Florida, the West Indies, and Brazil.

Eupagurus longicarpus, Stimpson.

Eupagurus pollicaris, Stimpson, Proc. Acad. Nat. Sci., Philadelphia, 1858, p. 237. Ibid., Annals N. Y. Lyceum, vii. p. 92. Coues, l. c., p. 124. Smith, Fish Commission, p. 548.

Massachusetts to Florida; Fort Macon (Coues, Packard).

THALASSINOIDEA.

Gebidae.

Gebia affinis, Say.

Gebia affinis, Say, l. c., i. p. 241. Dekay, op. cit., p. 22. Gibbs, l. c., iii. p. 195. Smith, Fish Comm., p. 549, pl. ii. f. 7.

Long Island Sound to Florida.

Callinassidae.

Callinassa stimpsoni, Smith.

Callinassa stimpsoni, Smith, Report U. S. Fish Commission for 1871-72, p. 549, pl. ii. f. 8.

Long Island Sound, southward.

Callinectes major, Stm.

Callinassa major, Say, l. c., i. p. 238. Edw., Hist. Nat. Crust., ii. p. 310. Dekay, op. cit., p. 22. Gibbs, Proc. Am. Assoc., iii. p. 194. Stimpson, Am. Journ., ii. xxix. p. 444.

Callinectes major, Stm., Ann. Lyc., x. p. 122.

Fort Macon (Stimpson) to Florida.

ASTACOIDEA.

Astacidae.

Homarus americanus, Edw.

Homarus marinus, Say, l. c., i. p. 165 (non Fabr.).

Homarus americanus, M. Edw., Hist. Nat. des Crust., ii. p. 234. Gould, op. cit., p. 330. Dekay, op. cit., p. 23, pl. xii. Gibbs, l. c., p. 195. Coues, l. c., p. 124. Smith, Trans. Conn. Acad., ii. pp. 251-381, 5 plates (Development). Ibid., Fish Comm., p. 549, pl. ix. f. 38-39. Wheldon, Proceedings American Association, xxiii. p. 133, 1874. Kingsley, American Naturalist, 1876, x. p. 396, pls. v., vi.

New Jersey to Labrador (Smith). Dr. Coues reports a single specimen from Fort Macon.

CARIDEA.

Crangonidae.

Crangon vulgaris, Fabricius.

Crangon vulgaris, Linne, Syst. Nat., 12th Edit., p. 1052.

Crangon vulgaris, Herbst., Naturgeschichte der Krabben und Krebse, l. p. 57, pl. xxix. f. 3 and 4. Olivier, Encyclopedie Methodique, t. vi. p. 345, pl. ccxciv. f. 4-7.

Crangon vulgaris, Fabricius, Suppl. Ent. Syst., p. 410. Latreille, Hist. Nat. des Crustacés, vi. p. 267, pl. iv. f. 1-2. Lamarck, Anim. sans Vertebres, v. p. 202. Leach, Malacostraca Podophth. Brittablae, pl. xxxvi. f. B. Desmarest, Consid. sur les Crustacea, p. 218, pl. xxxviii. f. 1. Edwards, Hist. Nat. des Crustaces, ii. p. 841. Gould, Invert. Mass., p. 331. Kroyer, Naturhistorisk Tidsskrift, 1842-3, p. 239, pl. iv. f. 29-33. Brandt in Middendorff, Bd. ii. th. i. p. 112. Gibbes, l. c., iii. p. 193. Bell, British Stalk-eyed Crustacea, 1852, p. 256. Stimpson, Invertebrata of Grand Menan, p. 58. Sars, Videnskabs Selskabet, i Christiania, 1861, p. 179. Kinahan, Proc. Royal Irish Academy, 1862, vii. p. 68 and 71, pl. iv. (poor figures). Heller, Crustaceen des Sudlichen Europa, 1863, p. 226, pl. vii. f. 8-9. Smith, Fish Comm., p. 551, pl. iii. f. 10. Meinert, Naturhistorisk Tidsskrift, 1877, III. xl. p. 198. Kingsley, Proc. Acad. Nat. Sci., Philadelphia, 1878, p. 89. Ibid., Bulletin Essex Inst., 1878, x. p. 58.

Crangon septempinosus, Say, l. c., p. 246. Dekay, op. cit., p. 25, pl. viii. f. 24.

Mediterranean, France, England, Norway, Labrador, south to Fort Macon (Packard).

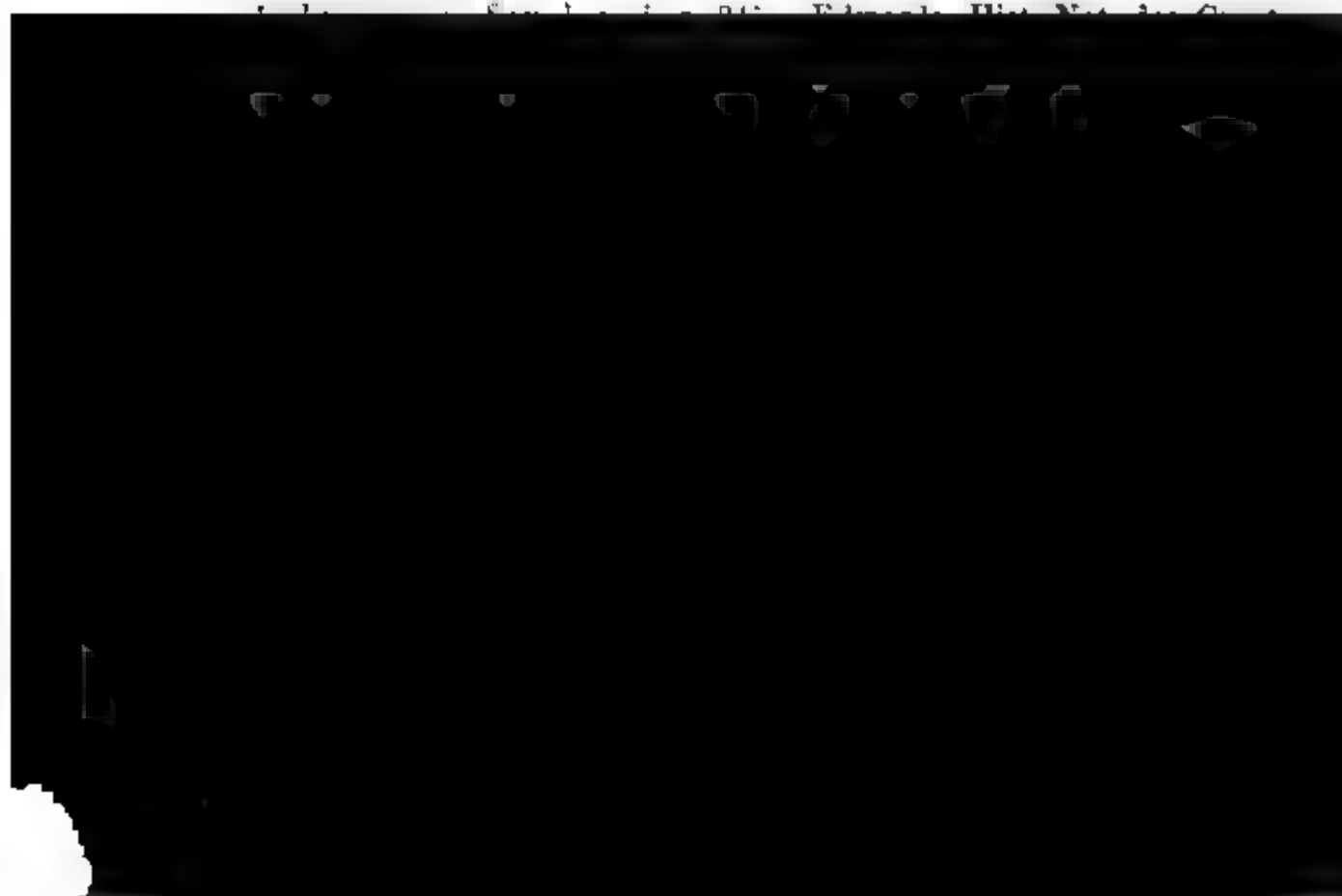
Tozeuma carolinensis, Kingsley.

Tozeuma carolinensis, Kingsley, Proc. Acad. Nat. Sci., Philadelphia, 1878, p. 90; ibid., Bulletin Essex Inst., x. p. 56.

This species was found to be quite common in the eel grass near Fort Macon, by Dr. Packard. It is readily recognized by its slender elongate form and its long straight rostrum.

Palaemonidae.

Alpheus minus, Say.



In the Annual Report of the U. S. Geological and Geographical Surveys of the Territories for 1874, p. 388, Mr. Ernest Ingersoll says, "From the pond mentioned, between camps E. & F. [in southwestern Colorado], a small crab was brought home, which Prof. S. I. Smith pronounced to be a true marine form, belonging to the *Aslacidoæ* (sic)." Prof. Smith informs me that the specimen shown to him was undoubtedly *Alpheus minus*, and thought it more than probable that some confusion of localities or mixture of specimens had occurred, but, on the other hand, Mr. Ingersoll was as positive as it is possible to be that the specimen was found in the pond mentioned.

Alpheus heterochelis, Say.

Alpheus heterochelis, Say, l. c., i. p. 243. Edwards, op. cit., ii. p. 356.

Dekay, op. cit., p. 26. Gibbes, l. c., p. 196. Smith, Trans. Comm.

Acad., ii. p. 23 and 39. Kingsley, Bulletin U. S. G. and G. Survey, iv. p. 194; *ibid.*, Bulletin Essex Inst., x. p. 58. Lockington, Annals and Mag. Nat. Hist., 1878.

Alpheus armillatus, Edw., op. cit., ii. p. 354.

Halopsyche lutaria, Saussure, Revue Zoologique, 1857, p. 100 (teste Saussure).

Alpheus lutarius, Saussure, Crustacés nouv. Antilles, Mexique et Etats Unis, p. 45, pl. iii. p. 24. E. von Marten, Archiv für Naturgeschichte, 1872, p. 139.

Alpheus equidactylus, Lockington, Proc. California Academy, vii. p. 35, 1877. (Extras published in 1876.)

I have examined specimens from Fort Macon (Dr. H. C. Yarrell), Florida, Bahamas, Bermudas, Brazil, Aspinwall, Panama, and the West Coast of Nicaragua. Mr. Lockington informs me that his *A. equidactylus*, from Monterey, Cal., presents no appreciable differences from specimens of *A. heterochelis*, from Florida, that I sent him. This species is readily recognized by its front with a single spine, its enormous hand, and is larger than the preceding species.

Stimpson in his "Trip to Beaufort, N. C.," American Journal of Sciences and Arts, 2d series, vol. xxix. p. 444, mentions a species of *Alpheus* under the name *A. intermedius*. What he refers to is unknown.

Virbius pleuracanthus, Stimpson.

Virbius pleuracanthus, Stimpson, Annals N. Y. Lyceum, 1871, x. f. 127. Smith, Fish Comm. p. 550. Kingsley, Bulletin Essex Inst. x. p. 63.

New Jersey to Fort Macon (Dr. Packard).

Urocaris longicaudata, Stimpson.

Urocaris longicaudata, Stimpson, Proc. Acad. Nat. Sci., Philadelphia, 1860, p. 39. Kingsley Bulletin Essex Inst., x. p. 65.

"In littoribus Carolinensibus habitans" (Stimpson).

Palæmonetes vulgaris, Stimpson.

Palæmon vulgaris, Say, l. c., i. p. 248. Edw., Hist. Nat. des Crust., 3. p. 394. Gould, op. cit., p. 332; Dekay, op. cit., p. 29, pl. 12 f. 2. Gibbes, l. c., p. 198. Coues, l. c., p. 124.

Palæmonetes vulgaris, Stimpson, Annals N. Y. Lyceum, x. p. 133. Smith, Fish Comm. p. 550, pl. ii. f. 9. Kingsley, Bulletin Essex Inst., x. p. 65.

Salem, Mass. (C. Cooke), to Florida. Fort Macon (Dr. Packard).

Palæmonetes carolinus, Stimpson

Palæmonetes carolinus, Stimpson, Annals N. Y. Lyceum, x. p. 133. Kingsley, Bull. Essex Inst. x. p. 65.

New Jersey to South Carolina; Fort Macon (Dr. Packard).

Penæidae.**Penæus setiferus**, Edw.

Cancer setiferus, Linne (teste Edw.).

Penæus fluviatilis, Say, l. c., i. p. 286.

Penæus setiferus, Edw., op. cit., ii. p. 414. Dekay op. cit., i. p. 29. Gibbes, l. c., iii. p. 199. Smith, Trans. Conn. Acad., ii. p. 133. Stimpson, Annals Lyceum, x. p. 133. Kingsley, Bull. Essex Inst., x. p. 65.

SEPTEMBER 3.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-one persons present.

On the Black Mildew of Walls.—Prof. LEIDY remarked that in the number of "Hardwicke's Science Gossip" for August, presented this evening, there is an article by Prof. Paley entitled "Is the Blackness on St. Paul's merely the effect of Smoke." According to the author, the blackness is mainly due to the growth of a hitherto undescribed lichen, which appears to flourish only on limestone and in situations unaffected by the direct rays of the sun. Prof. Leidy continued, that his attention had been called a number of years ago to a similar black appearance on the brick walls and granite work of houses in narrow shaded streets, especially in the vicinity of the Delaware River. Noticing a similar blackness on the bricks above the windows of a brewery, from which there was a constant escape of watery vapor, in a more central portion of the city, he was led to suspect that it was of a vegetable nature. On examination, the black mildew proved to be an alga, closely allied to what he supposed to be the *Protococcus*, which gives the bright green color to the trunks of trees, fences, and walls, mostly on the more shaded and northern side, everywhere in our vicinity. It probably may be the same plant in a different state, but, until proved to be so, may be distinguished by the name of *Protococcus lugubris*. It consists of minute round or oval cells, from 0.006 to 0.009 mm. in diameter, isolated or in pairs or in groups of four, the result of division; or it occurs in short irregular chains of four or more cells up to a dozen, occasionally with a lateral offset of two or more cells. The cells by transmitted light appear of a brownish or olive-brownish hue. In mass to the naked eye the alga appears as an intensely black powder.

SEPTEMBER 10.

The President, Dr. RUSCHENBERGER, in the chair.

Nineteen persons present.

The death of Geo. Dawson Coleman, a member, was announced.

SEPTEMBER 17.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-eight persons present.

A paper entitled "Description of a supposed New Species of *Smynthurus*," by John A. Ryder, was presented for publication.

Remarks on Mactra.—Prof. LEIDY remarked that the most frequent and conspicuous shell met with on the sandy coast of New Jersey was the Beach-clam, *Mactra solidissima*. The living mollusk was thrown up in great numbers during severe storms; and high above the position reached by ordinary tides, its dead shells are thickly strewn over the sands. Shells are often met with having a smooth circular hole bored near the umbo, which appeared to be due to *Natica heros*, for several years ago, at Atlantic City, on the beach, near low-tide mark, Prof. L. had dug out of the sands many specimens of *Natica*, each of which embraced a beach-clam. The tongue of the *Natica*, covered with strong teeth, and over an inch long, formed a rasp, well adapted for boring the shell of its prey. Why the *Natica* always made choice of the position near the umbo for boring through the shell did not appear clear, though perhaps it might have something to do with reaching the adductor muscles of the shell of the *Mactra*. These are equidistant from the perforation, and, if torn through by the tongue of the *Natica*, would cause the shell of the *Mactra* to open, and thus render all the soft parts more accessible.

The *Mactra* lives in the sands of the coast, and appears to feed chiefly on diatoms and perhaps infusorians. Prof. L. had been

to extricate itself from the sand to occupy a position on the surface.

Diatoms, from their constitution, are admirably adapted as food for the beach-clam, oyster, and other lamellibranch mollusks. They are crystal cases containing besides the endochrome, a quantity of colorless protoplasm, and considerable drops of oil. They might be likened to boat loads of corn, meat, and oil. In the materials of the commencement of the intestine of clams and oysters, Prof. L. had observed the diatoms with the contents in various conditions of change due to digestion; and in the materials of the rectum, the diatoms were empty or had been deprived of their contents.

In several beach-clams examined, among the matter of the intestine, Prof. L. had observed what he at first supposed to be the shell of a diiflugian, but which he since suspected to be that of a related infusorian, *Tintinnus*. In form and construction the shell resembles that of *T. annulatus* (Fig. 2, pl. 9, vol. i., Etudes sur les Infusoires, etc., Claparede and Lachmann). Its length was 0.78 to 0.12 mm., the breadth 0.024 to 0.036 mm.

The *Amphiprora constricta* above referred to was from 0.078 to 0.099 mm. long, 0.024 broad, and 0.012 mm. thick.

Irritable or Sensitive Stamens.—Mr. THOMAS MEEHAN remarked on the large list of plants now known that exhibited an irritative motion in some of their parts. A few years ago there were few plants known besides the Sensitive plant and the Venus fly-trap; but there were many scores of similar cases known, though chiefly as regards the stamens or portions of the pistils. He had already on record a large number of instances in plants of the orders *Ericaceae*, *Scrophulariaceae*, and *Acerthaceae*, and he had collected so many cases that he thought wherever there were bilobed patterned stigmas in these orders, we might expect to find this sensitive motion to touch exhibited in a greater or less degree. In regard to stamens, it was well known that in *Opuntia*, a family of *Cactaceae*, the stamens moved in various directions when touched, and it was very remarkable that no such motion had been observed in *Cereus*, *Mammillaria*, and other allied genera of the order. Having noted a similar motion in the stamens of the common garden *Portulaca grandiflora*, he was led to look for and to find a similar motion in the Purslane, *Portulaca oleracea*. Examining another Portulacaceous plant, *Talinum terretifolium*, last year, he could find no trace of motion, but when on his recent journey to St. Louis, he found growing in the Botanic Garden of Mr. Henry Shaw, of St. Louis, a West Indian species, *Talinum patens*, in which the expanded stamens fell down on the petals when touched. It was remarkable that this power should exist in *T. patens* and not in *T. terretifolium*, though some approach to this exceptional character was already noted in the genera, though not among the species of *Cactaceae*.

The objects of these movements may yet form an interesting study. In *Dionæa*, *Drosera*, and some others, the motion has been found to result in some immediate benefit to the plant; *Mimosa*, *Hedysarum*, and others, no such immediate benefit has been suggested. In the case of sensitive stigmas it had been supposed to have some reference to arrangements for cross-fertilization. But this was doubtful for the following reasons: In the case of *Mimulus ringens* the stigmas expanded, and the anthers dispersed their pollen before the corolla was quite open, and pollen might be generally found on the stigmatic surfaces when the mouth exposed these parts to view. In *Tecoma radicans*, on the other hand, the lobes of the pistil did not expand till some time after the mouth of the corolla was open. In many cases pollen hunting bees had carried away all the pollen before these lobes expanded. In cases where the expanded lobes and dispersing pollen were simultaneous, it was theoretically supposed that a bee or insect touched the lobes with its pollen-covered head or back and that the lobes then closed against the admission of pollen or the withdrawal of the insect from the flower. But he had found that the bees in the cases observed by him occupied but from three to five seconds in visiting a flower, while it took from thirty to sixty seconds for the lobes to close, and then they were seldom so completely closed as to render the reception of fresh pollen difficult. He thought from these and other facts that the hypothesis in relation to cross fertilization was untenable, and that the real use of this motion in the economy of nature was an open and yet promising field to the future investigator.

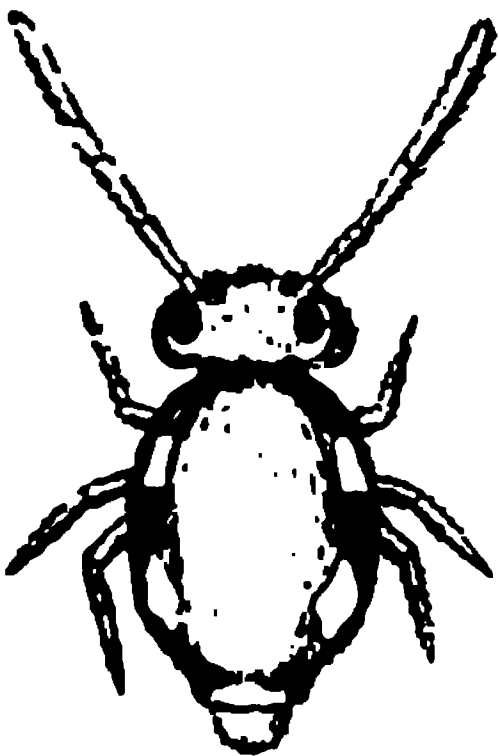
DESCRIPTION OF A NEW SPECIES OF SMYNTHURUS.

BY JNO. A. RYDER.

Smynthurus quadrimaculata, Nob.

Dark brown, nearly black on the sides; median dorsal and ventral surfaces lighter; spring and middle of legs still more pale.

Its distinguishing character consists in the two pure white spots, one down on each side of the abdomen, the posterior ones larger



than the anterior by one-third to one-half, are arranged, when the back of the animal is viewed from above, in an equilateral quadrangle. The surrounding dark color immediately bordering the white spots is intense, but becomes paler more remote from them in all directions, and especially on the middle of the back. Antennae four-jointed, smynthuriform, resembling those of *S. Bourletii*, Gerv.

Length from front of head to tip of abdomen .5 mm.; vertical diameter of abdomen .3 mm.; width of abdomen .23 mm.

This remarkably beautiful little Collembolan was found in company with a large species of *Papirius*, apparently near *P. ornatus*, Newell, feeding on a polyporous fungus which grew on a stump in a damp, shady ravine in East Fairmount Park. It is one of the rarest of our American species of *Smynthurida*, and is totally distinct from any described by Say, Harris, or Fitch, some of which are no doubt *Papirida*. It may be one of the species which the latter entomologist mentions as being known to him, but to which he did not give names. The descriptions of both Harris and Fitch, in the absence of good figures, are vague and unsatisfactory.

The species I have no doubt will prove to be one new to science. In form it greatly resembles the *S. Bourletii*, but in marking and color it is so totally distinct that it would be immediately recognized as different.

OCTOBER 1.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-nine persons present.

The death of Thomas Potter, Sr., a member, was announced.

Foraminiferous Shells of our Coast.—Prof. LEIDY remarked that the vast numbers of Foraminiferous shells, which formed a constituent of the sea-side sands, had been a subject of frequent notice. Feeling interested to know their proportionate quantity on the comparatively barren shore of New Jersey, he had examined the sand at Atlantic City, and at Cape May. The sand in these localities mainly consists of quartz, with black grains, often in considerable quantity, and formerly largely collected for "writing sand," which he supposed to consist of ilmenite and magnetite. Among these were also brilliant red particles, which he supposed to be garnet. All these materials are the comparatively insoluble residue of our inland gneissic, and other rocks.

In sand scraped up from the surface between the tides at Atlantic City, he had found the Foraminiferous shells, all of one species of *Nonionina*, resembling that figured by Ehrenberg as *N. polypora*. They were found in the proportion of about 19,000 to the ounce avoirdupois of sand. In sand, obtained in the same manner at Cape May, there were about 38,000 shells, of the single species just named, to the ounce avoirdupois of sand.

The sands on the rocky New England coast are much richer in Foraminiferous shells, both in numbers and kinds, but they are generally smaller. In sand from the bathing beach at Newport, R. I., collected from the white wash left by the edge of the waves,

only were of mature size. In many positions they were so numerous, that they appeared like rolling pebbles, as they were exposed by the breaking of the surf on the shore, and as they rapidly followed the receding waves, and buried themselves in the sand. The sand, on being dug up, was found to be as full of them as an ordinary plum-pudding is of currants.

Below Ocean Grove, near low-tide mark, the Lady Crab, *Platystrophia ocellatus*, was frequent. Above Ocean Grove, and above the high-tide line, in the dry sand, and in the bank covered with Sea-sand Grass, *Calamagrostis arenaria*, the burrows of the Sand Crab, *Ogyropsis arenaria*, were numerous, and the animals frequent. One of these crabs, brought home after eight days, was still in good condition without once having been in water. It appeared to be fond of meat of any kind, and had been fed on beef and oysters.

Supplementary Note on the Aeronautic Flight of Spiders.—Rev. H. C. McCook remarked that, in the Proceedings of the Academy for 1877, pp. 308–312, would be found the result of some observations made by him upon the ballooning habits of spiders, which he was now able to supplement by several important items. The facts which he had to detail were observed Oct. 1, 1878, upon the farm of Mr. Geo. B. Lownes, about ten miles from Philadelphia, in Delaware County; and they would best be presented by giving the record made in his note-book of the flight of several spiders. The day was warm and bright, and a gentle breeze was blowing throughout the day, but not steadily from any quarter.

No. 1. A young Lycosid, apparently *Lycosa scutulata*, Hentz. On the side of a fence-post opposite to the wind, face downward, abdomen elevated, the body raised by the legs. Followed it after flight for 200 feet; it rose as high as 30 feet before it was lost sight of. Its flight was across a wide meadow, and promised to be a long one. Several threads were streaming out and up behind it before the spider.

No. 2. A saltigrade, probably the young of Hentz's *Attus citreus*, on the side of a fence-board opposite the wind. Its legs curved, raising up the body, abdomen turned well nigh straight forward, long thread floating out and up from the spinnerets; it moved several inches upward along the rail, keeping its body in the same stilted position, the thread meanwhile flying, and then was off, rather slowly, and about on a line with the face. There was one small thread in front and one (or more) behind. It moved straight forward for about 50 feet, and then rose suddenly upward.

No. 3. *Lycosa*, observed at 2 P. M. Actions as No. 1. Distinctly saw one thread before and apparently two behind; the front was toward the wind. After 15 feet it rose up and out of sight, a long stretch of meadow before it. Once before it mounted it lifted up one hind foot as though holding on to the stay thread.

No. 4. *Lycosa*. Followed for 40 to 50 feet; one thread apparently; in front a ray of several fine diverging threads floating behind from the spinnerets. Its back was toward the ground. Its abdomen seemed, but could not be certainly determined, to be riding in front. The body of the spider was thus at the apex of the angle formed by the fore and hind threads, the free points of which were quite far apart. The balloon struck a tree, and part of it went on, the spider apparently staying on the tree.

No. 5. *Lycosa*. The abdomen behind, i. e., toward the point of departure. Several threads floating from it, one in front; feet gathered together, but, apparently, the back upward. It crossed the highway, and a carriage just then passing interfered with the observation.

No. 6. The head riding in front, back down—this is absolutely certain. A four-shaped steamer of threads thrown out before mounting. At first it moved off slowly, soon climbed up the fore thread, the "bow," so to speak; further on it climbed up the pencil of rays for several inches. The balloon, when lost sight of, had at least three separate pencil rays visible. It was followed 100 feet before it rose out of sight.

No. 7. *Lycosa*. Back down; sailed sidewise part of the time; head forward apparently afterward.

Many of the aeronauts noticed first turned the elevated abdomen to various points, as though testing the direction of the wind.

Most of the points noted in the previous communication were confirmed, and those, together with these now presented, seem to make quite complete the mode of ballooning, at least among the Citigrade, and perhaps also the Saltigrade Spiders. The whole process may be briefly given as follows: 1. The spider seeks a high position, as the top of a fence post, as the point of ascent; 2. The abdomen is elevated to as nearly a right angle with the cephalothorax as may be; 3. A pencil of threads is issued from the spinnerets, the free ends of which are turned to various points

out behind, leaving the spider to ride in the angle of the two pencils, or 12, as it sometimes happens, of three, which diverge widely at the upper free ends; 13. The feet seem to be united by delicate filaments, which would serve to increase the buoyancy of the balloon; 14. The spider now is carried forward by the wind, riding for long distances in an open space, and often borne high upward upon ascending currents; 15. Its anchorage appears at times to be in its own volition, by drawing in with the claws the forward pencil and gathering it in a white roll within the mandibles, but, 16, most frequently the balloonist is stopped by striking against some elevated object or by the subsidence of the breeze; 17. A bright, warm day in October is commonly chosen for the ascent; and, 18, judging from the presence of a number of dry moults upon many posts, apparently of the same species of spider observed in flight, the animals had recently cast their skins. Of the above points, Nos. 3, 7, 9, 10, 11 in part, 12, 14 in part, 15 in part, and 18 are those which were determined by the last observation.

The object of this interesting habit seems to be the distribution of spores.

Some Characters in Negro Brains.—Dr. A. J. PARKER remarked that in a previous communication on the convolutions of the negro brain he had pointed out in one negro brain out of thirty-three then examined) the existence of an internal inferior pliciform convolution, which was as well developed as in any of the Simiadae. In the present brain the convolution measured a quarter of an inch in width, and completely separated the parieto-occipital or internal occipital calcar fissure from the calcarine, so that this region presented the same appearance as it does in the Simians. This convolution is uniformly present in the brain of all the Simiadae thus far described, except in *Ateles paniscus*, Huxley, and *Hylobates*, Eschsch. It had not been found in a fully developed condition in any before, and the absence of this small bridging convolution has been regarded by some anatomists as a distinguishing peculiarity of the human as compared with the anthropoid brain. Since it has been found this convolution present in another adult female negro brain. It was fully developed up to the surface, presented a superficial width of an eighth of an inch, and completely separated the parieto-occipital from the calcarine fissure. This convolution was, therefore, present in two cases out of thirty-three negro brains examined.

Taenzer describes (Edinburgh Medical Journal, 1866) a brain in which the fissure of Rolando joined the fissure of Sylvius completely, the small bridging convolution which usually separates them being completely absent. Pansch states that sometimes there is a superficial connection between these two fissures. Parker says he has never met with such an instance. Dr. Parker

had observed in one instance in the brain of an adult male negro the complete connection of these two fissures, no trace of a bridging or separating convolution being present.

OCTOBER 15.

The President, Dr. RUSCHENBERGER, in the chair.

Fifty-four persons present.

The following papers were presented for publication:—

“Descriptions of Ichneumonidæ chiefly from the Pacific Slope of the United States and British North America.” By E. T. Cresson.

“The Solar Corona.” By Jacob Ennis.

Notice of a Tetrarhynchus.—Prof. LEIDY stated that in the *Remora*, or Sucker, from our coast, presented this evening by Mr. Holbrook, he had found a curious parasite. This was inclosed in a compressed oval cyst, pearly white, thick-walled, and about half an inch long, tightly adherent to the intestine of the fish. The cyst contained a flask-shaped, translucent whitish sac, which was feebly contractile, and furnished at the narrow end with two minute papillæ, which were slowly protruded and retracted. Within this sac-worm, coiled up about the centre, was an opaque white worm or scolex, which proved to be a *Tetrarhynchus*. Removed and extended it measured 7 lines long, and was divisible about equally into a broad anterior body portion, and a posterior narrow tail-like portion. The head was formed of a pair of obcordate bothria inclined from each other. Four long tortuous pro-

OCTOBER 22.

The President, Dr. RUSCHENBERGER, in the chair.

22 persons present.

OCTOBER 29.

The President, Dr. RUSCHENBERGER, in the chair.

100 and seven persons present.

A paper entitled "On the Structure of the Gorilla," by H. C. M.D., was presented for publication.

A paper of Jonathan S. Helfenstein, a member, was announced.

Mr. Brinton and Messrs. Wm. T. Haines, Edmund Lewis, Ayres were elected members.

A paper was ordered to be printed:—

RECOVERY OF ALL THE FACULTIES IN A PIGEON FROM WHICH FORTH-FIFTHS OF THE UPPER PORTION OF THE CEREBRUM HAD BEEN REMOVED.

By J. H. McQUILLEN, M.D.

Monday, February 4th, 1878, in illustration of my regular course of lectures on Physiology in the Philadelphia Dental College, I exposed the cerebrum of a pigeon, as I have regularly done each session for the past twenty years, and cut out four-fifths of the upper portion in slices, to illustrate the fact that the sensorium thus exposed could be cut, pinched, or burned without any manifestation of suffering on the part of the animal. The usual phenomena attendant upon the operation followed, a profound stupor, the bird standing motionless on the table, with eyes closed, the head sunk between the shoulders, and the feathers ruffled. When pushed it opened its eyes and moved the body, when thrown into the air it flew a few feet, and then on lighting relapsed into somnolency with an evident obliviousness to surrounding objects until again aroused by handling. In this condition, along with another pigeon from which the cerebrum had been removed, it was shown to the members of the Biological and Microscopical Section of the Academy of Natural Sciences on the evening of that day at the regular monthly meeting of the

power of feeding itself and drinking as usual, and the general manifestation of intelligence. There could be no question about the identity of the pigeon. It was of a peculiar breed, and the cratrix on the neck, where the incision had been made so as to throw the scalp back and expose the cranium, along with a soft piece on the latter from which a portion of bone had been removed, left no doubt on that point. I again exhibited it at the monthly meeting of the Biological and Microscopical Section, March 4th, and the members were surprised to find it fly about from one end of a long room and back again, feed itself, etc.

I asked then, and I repeat now the same question, How are we to account for the restoration of these functions? Is it due to the fact that the small portion of the cerebrum left after the operation assumed the functions of the entire organ, or has there been a regeneration of the part removed? Vulpian, one of the most accurate and reliable of the recent experimentalists and observers of these phenomena, positively asserts that an animal from which the cerebral hemispheres have been removed, is incapable of a spontaneous voluntary movement. In this he is apparently supported by every observer, with only one exception, Voit.

The latest author, in writing on this subject, M. Foster¹ (whose views may be regarded as summing those generally entertained), says: When the cerebral hemispheres are removed from a bird the animal is able to maintain a completely normal posture, and that too when the corpus striata and optic thalami are taken away at the same time. It will balance itself on one leg, after the fashion of a bird which in a natural way has gone to sleep. In fact the appearance and behavior of a bird which has been deprived of its cerebral hemispheres are strikingly similar to those of a bird sleepy and stupid. Left alone in perfect quiet, it will remain impassive and motionless for a long time, it may be for an almost indefinite time. When stirred it moves, and then on being left alone returns to a natural easy position. Placed on its side or on its back it will regain its feet; thrown into the air it falls with considerable precision for some distance before it returns to the ground. It frequently tucks its head under its wings, and if by accident it has been kept alive for some time after the operation, it may be seen to clean its feathers, and to pick up corn

¹ Text Book of Physiology, by M. Foster, M.A., M.D., F.R.S. London, Macmillan & Co., 1878.

or drink water presented to its beak.' It may be induced to move not only by ordinary stimuli applied to the skin, but also by sudden sharp sounds, or flashes of light; and it is evident that its movements are, to a certain extent, guided by visual sensations, for in its flight it will, though imperfectly, avoid obstacles. Save that all signs of volition are absent, that the movements are on the whole clumsy, resembling rather those of a stupid, drowsy bird than those of one quite wide awake, there is very little to distinguish such a bird from one in full possession of its cerebral hemispheres.

There is but one other case on record that I have met with, where there has been a recovery of voluntary action on the part of a pigeon from which the cerebral hemispheres had been removed, and I was not aware of that fact until the experience with my pigeon induced me to make a careful examination of the literature of the subject. I refer to the pigeon kept alive by Voit for five months after the cerebral lobes had been completely removed. "At first the pigeon presented the phenomena usually observed after this operation; but it gradually recovered, until it seemed entirely normal, with the single exception that it never would eat, all food being introduced forcibly. Five months after the operation the pigeon was killed, and the encephalic cavity was found filled with a white substance containing dark-bordered nerve-fibres and nerve-cells. Voit never before observed anything like regeneration of the nervous substance or so complete a restoration of the cerebral functions, and he regarded this as an instance of anatomical and physiological regeneration of the

ment as that made by Voit cannot be accepted without reserve, merely upon the basis of a single observation."

In contrast to this case it must be remembered that I only removed the upper four-fifths of the cerebrum. In doing this, however, the superficial gray matter of the hemispheres, recognized as the structure physiologically concerned in the exercise of the faculties of attention, perception, memory, and will, was removed.

The subject of the present communication continued in the full possession of its faculties for six months, when, in the presence of several scientific friends it was put to death under chloroform, and a *post-mortem* examination made. On removing the scalp a fibrous structure, analogous to pericranium, was found, occupying the place from which the bone had been removed, in making the vivisection. Cutting this away, a small amount of fluid escaped, and the cranial cavity thus exposed was found occupied by a white substance resembling the cerebral structure that had been removed six months before. Placing a section of the upper portion of this, which had been stained with hematoxyline, under the microscope, a number of bipolar cells characteristic of the gray structure were observed.

That the bird should have survived such an operation and lived for six months after in the full possession of its faculties, is a remarkable illustration of the recuperative powers of the system. And the regeneration of the parts removed is additional evidence and substantiation of the case reported by Voit.

Realizing that such an important question should merely rest upon my own observation, I requested the appointment of a committee by the Biological and Microscopical Section to examine the regenerated structure.

The following report on the microscopic characters of the regenerated tissue was prepared by Dr. Carl Seiler, Chairman of the Committee:—

"The specimen handed to me by Dr. J. H. McQuillen appeared to be the medulla, cerebellum, and part of the cerebrum of a bird. Intimately connected with the parts were two tumor-like growths, the one spherical, and of the size of a pea; the other of irregular shape, and smaller than the first.

"A microscopical examination of these growths revealed them to be composed of nerve-tissue, showing longitudinal and transverse

sections of nerve-fibres, and, in some places, multipolar *g* tonic cells. The bloodvessels which in the round growth appear to radiate from a common centre at the base of the growth are filled with oval blood-disks."

This report was accompanied by a section of the brain placed under the microscope, and a micro-photograph, showing the multipolar nerve-cells, prepared by Dr. Seiler.

NOVEMBER 5.

The President, Dr. RUSCHENBERGER, in the chair.

Sixty-six persons present.

The following papers were presented for publication :—

“On a Belt of Serpentine and Steatite in Radnor Township, Del. Co.” By Theodore D. Rand.

“Description of three new Species of Calceolæ, from the Upper Silurian Rocks of Kentucky.” By Victor W. Lyon.

Calluna Vulgaris.—Mr. THOMAS MEEHAN referred to a statement in a botanical periodical about the Heath being found apparently indigenous in New Jersey. He had visited the given location in company with Mr. Chas. F. Parker, one of the curators of the Academy, and gave his reasons in detail for concluding that it had been introduced probably about twelve years ago. It showed no disposition to get beyond the original place of planting.

He referred to the facts given in *Silliman's Journal* of 1861 and 1862, in regard to the discovery of the same plant at Tewkesbury, Mass., pointing out their inconclusive character, and expressing his opinion that, as in the New Jersey case, it was introduced there.

The following paper was ordered to be printed :—

DESCRIPTIONS OF ICHNEUMONIDÆ, CHIEFLY FROM THE PACIFIC SLOPE
OF THE UNITED STATES AND BRITISH NORTH AMERICA

BY E. T. CRESSON.

Ichneumon solitus, Cresson (Trans. Am. Ent. Soc., vi. 144)

♀.—Black, immaculate; mesothorax, scutellum and abdomen shining, the latter rather strongly tinged with blue or purple; antennæ rather stout, strongly involute, with a pale annulus beyond middle; third joint more than twice longer than broad, and conspicuously longer than the fourth; scutellum flat, polished, and nearly destitute of punctures; metathorax broadly and deeply excavated behind, central area large pentangular, rounded laterally and emarginate posteriorly; wings uniformly pale fuliginous; femora robust, anterior tibiæ pale in front; posterior coxæ nude; abdomen oblong ovate, finely, closely, and evenly punctured, apex polished; apex of first segment broadly dilated and punctured; gastrocæli small and deep. Length .30-.42 inch.

Hab. Lake Lahache, B. Col. (Crotch); Colorado (Smith).

Ichneumon odiosus, Cresson (Trans. Am. Ent. Soc., vi. 145).

♂.—Black; anterior orbits, dilated on sides of face, short in front of tegulæ, dot beneath, and tips of anterior femora and the four anterior tibiæ in front, white; scutellum convex, and

***Ichneumon neutralis*, Cresson (Trans. Am. Ent. Soc., vi. 149).**

♂.—Black; anterior orbits, broad on face, lower posterior orbits, dot on each side of clypeus, spot at base of mandibles, palpi, line before tegulae, short one beneath, dot on tegulae anteriorly, scutellum, anterior femora in front, four anterior tibiae in front and intermediate knees, all white; scutellum subconvex, sparsely punctured; metathorax transversely rugose, posterior face oblique, bounded above by a sharp carina, central area of moderate size, rounded anteriorly, and truncate posteriorly; wings smoky hyaline, nervures and stigma black; legs moderately slender; abdomen faintly tinged with blue, closely punctured, somewhat shining; apex of first segment not broadly dilated; gastrocæli deep. Length .56 inch.

Hab. California (H. Edwards). Closely allied to *subcyanus*, but is distinguished from that species by the posterior legs being entirely black.

***Ichneumon salvus*, Cresson (Trans. Am. Ent. Soc., vi. 166).**

♂.—Black; face, clypeus, mandibles, palpi, scape beneath, upper margins of prothorax, tegulae, short line beneath, scutellum and post-scutellum, yellow; mesothorax with two longitudinal, black ferruginous lines dilated anteriorly; scutellum convex, black, very abrupt at sides; metathorax entirely black, obliquely truncate behind, with large transversely quadrate central area; wings pale yellowish hyaline, stigma fulvous; legs yellowish, femora ferruginous, with coxae more or less black above, tips of posterior tibiae dusky; abdomen opaque, densely punctured, apex of first segment, and the second and third entirely, except narrow black posterior margin, yellow; fourth segment ferruginous, black at tip, remainder black; apex of first segment broad, coarsely longitudinally rugose and pyramidal in profile; gastrocæli very large and deep; apical segments almost smooth, and shining; antennae black, segments 2-4 yellowish ferruginous. Length .66 inch.

Hab. Vancouver's Island (H. Edwards).

***Ichneumon indemnus*, Cresson (Trans. Am. Ent. Soc., vi. 172).**

♂.—Long, cylindrical, ferruginous; suture at base of antennae, middle of vertex, spot inclosing ocelli, apex of antennae, sutures of thorax more or less, tips of posterior femora and of the tibiae, apex of second, third, and fourth abdominal segments and the

fifth and following segments entirely, black; head rather narrow, buccate; antennæ slender, third joint long and cylindrical, as long as first and second together, and nearly twice as long as the fourth; scutellum convex, yellow; metathorax truncate behind, central area large and oblong subquadrate; wings smoky hyaline; legs slender; abdomen long, narrow, linear, subcompressed at tip; first segment subquadrate at tip, slightly narrowed to base of second segment, so that the sides are somewhat rounded, lateral margins depressed, the raised middle being indistinctly accented; base of second segment narrowed, depressed, faintly longitudinally sculptured; gastrocæli subobsolete; last ventral segment long, narrow, not retracted. Length .42 inch.

Hab. British Columbia (Crotch).

Ichneumon purpuripennis, Cresson (Trans. Am. Ent. Soc., vi 175).

♀.—Ferruginous; head buccate; antennæ robust, with short, stout joints, black, the basal joints generally ferruginous, sometimes entirely black, apex more or less involute; scutellum flat, shining, sparsely punctured; metathorax opaque, finely rugosely punctured, rather deeply excavated behind, central area subquadrate; wings fuscous, with a more or less strong violaceous reflection, stigma varies from black to fulvous; legs subrobust, posterior tarsi sometimes fuscous; abdomen broadly fusiform, finely and closely punctured, becoming gradually less distinct beyond third segment, apex of first segment broadly dilated and angu-

***Ichneumon crudescens*, Cresson (Trans. Am. Ent. Soc., vi. 175).**

♂.—Head, antennæ, and thorax black; face yellow; mandibles, palpi, upper anterior orbits, scape, mesothorax except central black stripe, scutellum, metathorax above each side of central area and tegulæ ferruginous; scutellum convex, polished; central area of metathorax small, subrotund; wings violaceous black; legs and abdomen entirely ferruginous, the latter narrow, opaque, densely and finely punctured; apex of first segment narrow, aciculated; gastrocæli large and deep. Length .70 inch.

Hab. California (H. Edwards).

***Ichneumon compar*, Cresson (Trans. Am. Ent. Soc., vi. 175).**

♂.—Ferruginous; head strongly buccate, anterior orbits and palpi yellowish; antennæ with short stout joints, apex black; collar yellow above; scutellum flat, shining, sparsely punctured; metathorax strongly punctured, posterior face deeply excavated, bounded above by a sharp carina, central area quadrate; sutures of thorax sometimes more or less broadly margined with black, in one specimen the pleura beneath is almost entirely black; wings yellowish fuscous, stigma honey-yellow; femora robust, sometimes the posterior tibiae is more or less yellowish at base, and the anterior legs tinged with yellow in front; abdomen fusiform, very densely and finely punctured, smooth at apex; apex of first segment broadly dilated and longitudinally aciculated; gastrocæli rather large and deep. Length .55 inch.

Hab. Vancouver's Island (H. Edwards). Closely allied to *pallidus*, which has stouter antennæ, with shorter basal joints, etc.

***Ichneumon difficilis*, Cresson (Trans. Am. Ent. Soc., vi. 176).**

♂.—Head black, upper anterior orbits, face, clypeus, mandibles, except tips, palpi, and scape beneath yellow; thorax black, upper margin of prothorax, large furcate mark on mesothorax, scutellum, and metathorax above more or less ferruginous; tegulæ, ventral line beneath and sometimes the scutellum, yellow; scutellum subconvex, polished; wings fuscous, stigma fulvous; legs ferruginous, coxæ and tips of posterior tibiae black; abdomen ferruginous, densely punctured, opaque, base of segments three, four, and five, more or less black; apex of first segment coarsely aciculated; gastrocæli large and very deep. Length .56 inch.

Hab. California (Behrens).

Var.? Pale ferruginous; thorax same as the above, with the scutellum yellow; *four anterior coxæ yellow*; apex of first abdominal segment nearly smooth, scarcely aciculated; black bands at base of segments 3—5 narrow.

Hab. Vancouver's Island (H. Edwards).

Ichnonomen nuxius, Cresson (Trans. Am. Ent. Soc., vi. 176).

♂.—Black; face, anterior orbits, lower posterior orbits, clypeus, mandibles except tips, scape beneath, upper margin of prothorax, tegulæ, short line beneath, scutellum, post-scutellum, and posterior face of metathorax more or less pale yellow; mesothorax with two pale lines or a spot on the disk; scutellum convex, polished; elevated lines of metathorax sharply defined, posterior face obliquely truncate, central area quadrate; wings hyaline, dusky at tips, stigma fulvous; legs ferruginous, four anterior coxæ and trochanters yellow, their femora, tibiæ, and tarsi yellowish in front; posterior coxæ, trochanters and tips of their tibiæ black; apex of their coxæ beneath, and tips of their tarsi yellowish; abdomen ferruginous, first segment black, with the apex ferruginous, aciculated; gastrocæli rather large and moderately deep. Length .55 inch.

Hab. California (H. Edwards).

Ichnonomen sequax, Cresson (Trans. Am. Ent. Soc., vi. 181).

♀.—Ferruginous, shining, finely, rather feebly punctured; anterior orbits pale; antennæ long, slender, black, scape ferruginous, third joint long, cylindrical, longer than fourth, apex of flagellum attenuated; scutellum broad, flattened, broadly truncate at tip, the lateral region basal excavation and carinae, clypeus except

joints short, third about twice longer than broad and subequal with fourth; scutellum flattened; metathorax obliquely truncate behind, central area quadrate; wings dusky, stigma yellow; legs slender, four posterior coxæ black, ferruginous at tips; abdomen fusiform, depressed, densely coarsely sculptured, smooth and shining at apex; first segment rather broadly dilated at tip, and coarsely longitudinally sculptured, gastrocæli obliquely linear. Length .30 inch.

Hab. Aleutian Islands (H. Edwards).

***Ichnæumon cestus*, Cresson (Trans. Am. Ent. Soc., vi. 182).**

♂.—Pale ferruginous, opaque, densely and finely punctured; antennæ slender, third joint long, cylindrical, much longer than fourth, apical joints blackish; anterior angle of prothorax, basal excavation of scutellum, basal suture of metathorax, irregular patch on disk of second abdominal segment and broad band at base of third segment, black; scutellum depressed, polished, punctured, sides abrupt, apex rounded; metathorax coarsely punctured, excavated behind, with spiniform lateral angles, central area quadrate, not well defined; wings yellowish hyaline, a fuscous cloud along base of first submarginal cell, stigma fulvous; tips of posterior tibiae slightly dusky, their coxæ beneath with a small pubescent patch near tip; abdomen fusiform, apex of first segment broad and finely scabrous; gastrocæli transversely linear, rather abrupt. Length .40 inch.

Hab. Vancouver's Island (H. Edwards). Easily recognized by the broad black band at base of third abdominal segment, and by the subflescite wings.

***Ichnæumon russatus*, Cresson (Trans. Am. Ent. Soc., vi. 183).**

♂.—Ferruginous; head and mesothorax sparsely punctured; scutellum quadrate, middle of face prominent; antennæ short, robust, strongly involute, scape subglobose, third joint nearly subquadrate, and equal with fourth, the joints towards apex thickened, pubescent; scutellum flat, polished, with a few scattered punctures; metathorax deeply excavated behind, with rather prominent spiniform lateral angles, central area subquadrate; sutures of mesothorax beneath, suture at base of scutellum, as well as its anterior margin, and lower margin of metathorax, black; wings fuscous; abdomen fusiform, very densely and minutely sculptured, second and third segments, apical segments smooth and

shining; apex of first segment gradually dilated, rather coarsely aciculated, depressed, not at all raised medially; gastrocæli ^{sub}obsolete; a fuscous stain on second segment (which may be ^{sub}dental). Length .40 inch.

Hab. Vancouver's Island (H. Edwards).

Ichneumon semisialis, Cresson (Trans. Am. Ent. Soc., vi. 183).

♀.—Ferruginous, opaque; head broad, sub-buccate; antennæ moderately slender, dusky at tips, third joint more than twice longer than broad, and a little longer than fourth; anterior angle of mesothorax and basal and lateral regions of scutellum black; scutellum subconvex, shining, rounded at tip; metathorax roughly punctured, rather deeply excavated behind, with prominent obtuse lateral angles, central area quadrate; wings pale yellowish-fuscous; abdomen fusiform, rather strongly punctured on second segment, apical segments gradually smoother and shining; apex of first segment gradually, rather broadly dilated and feebly aciculated; gastrocæli shallow, not well marked. Length .40 inch.

Hab. Mohave Desert, California (Crotch).

Ichneumon petulous, Cresson (Trans. Am. Ent. Soc., vi. 185)

♀.—Small, robust, ferruginous, shining; head strongly buccate; face short and prominent on middle, polished; antennæ short, robust, with short close-set joints, scape globose; third joint nearly quadrate, equal with third, flagellum obfuscated; frons behind antennæ deeply excavated, occiput deeply emarginate;

rate behind, lateral angles very prominent, obtuse, central area quadrate, sometimes longitudinally rugose; wings uniformly fuliginous, with a strong violaceous reflection, nervures and stigma black; legs, with coxæ, ferruginous, sometimes brownish-ferruginous, posterior tibiae fuscous, the base often more or less ferruginous, their tarsi whitish with basal joint almost entirely fuscous; abdomen broad, ovate, depressed, shining at tip, second and third segments closely and strongly punctured, the punctures confluent at base of second, gastrocoeli large and deep; apex of first segment broad, scabrous; venter shining. Length .70 inch.

♂.—More slender; sides of face yellow; clypeus, labrum, and scape beneath ferruginous, flagellum entirely black; legs pale ferruginous. Length .55 inch.

Hab. Vancouver's Island (H. Edwards).

Amblyteles mormonus, Cresson (Trans. Am. Ent. Soc., vi. 190).

♂.—Deep black; four anterior legs, except coxæ and trochanters, and posterior femora ferruginous; antennæ long, slender, basal joints of flagellum long and cylindrical; head small, cheeks flat; thorax robust, strongly punctured; scutellum depressed; metathorax obliquely truncate behind, central area transverse; legs fuscous; wings fuscous, rather paler at tips; legs subrobust, posterior tibiae and tarsi unusually robust, the latter short; abdomen broadly fusiform, opaque at base, shining at tip, apex of first segment broad, aciculated; second and third segments closely and strongly punctured, longitudinally rugose at base of second, gastrocoeli small and deep; last ventral segment scarcely retracted. Length .45 inch.

Hab. Great Salt Lake, Utah.

Amblyteles hiulens, Cresson (Trans. Am. Ent. Soc., vi. 191).

♂.—Long, narrow, cylindrical, shining ferruginous; sutures of thorax, apex of posterior tibiae and sometimes of their femora, and basal margins of abdominal segments 3-5, black; head narrow, buccate, antennæ long, slender, curled, and fuscous at tip, third joint at least three times longer than broad, cylindrical, much longer than fourth; mesothorax strongly punctured, convex; scutellum subconvex, polished; metathorax obliquely truncate behind; wings dusky-hyaline, stigma yellow; legs slender; abdomen smooth and polished, long, narrow, subcompressed at tip; apex of first segment narrow, with almost parallel sides,

depressed above and indistinctly sculptured; base of second slightly narrowed, depressed, very finely and sparsely punctured, gastrocæli longitudinal, subobsolete; last ventral segment long, narrow, not retracted. Length .48 inch.

Hab. Lake Lahache, British Columbia (Crotch).

Trogus Edwardsii, Cresson (Trans. Am. Ent. Soc., vi. 195).

♂.—Black; head transversely subtriangular, not at all buccate; face, clypeus, labrum, mandibles, palpi, narrow upper anterior orbits, line on posterior orbits, scape beneath, and most of flagellum beneath, two spots in front of mesothorax, scutellums, elevated disk of metathorax and tegulæ, ferruginous; scutellum acutely pyramidal; metathorax with two sharp longitudinal ridges behind, between which the surface is coarsely and transversely rugose; wings blackish-fuliginous, violaceous; legs slender, yellowish-ferruginous, four anterior coxæ at base and posterior pair entirely black; abdomen depressed, longitudinally aciculated, the segments strongly constricted at base, especially at sides, ferruginous, a black spot on disk of second and following segments, becoming gradually larger, until the one on the fifth covers nearly the entire upper surface of the segment; apex of first segment quadrate, narrowing suddenly before tubercles; gastrocæli large and deep. Length .73 inch.

Hab. Vancouver's Island (H. Edwards). A very pretty species.

Trogus buccatus, Cresson (Trans. Am. Ent. Soc., vi. 199).

♀.—Robust, ferruginous; head large, strongly buccate, cheeks much swollen; tips of mandibles and antennæ, except base, black;

spot on tegulae and a line beneath, white; antennae as long as the body, slender; scutellum distinctly margined, with a pale spot towards tip; metathorax obliquely truncate behind, lateral angles small, subspiniform; wings hyaline; legs blackish, tips of posterior coxae, their trochanters and all the femora ferruginous, spot on anterior coxae beneath, spot on four anterior trochanters and their femora and tibiae in front whitish; abdomen shining, feebly punctured; gastrocaeli deep, transverse. Length .35 inch.

Var. Abdomen black, with segments 2-5 narrowly margined with red at apex; metathorax entirely black, legs mostly black, posterior femora only tinged with red.

Hab. California (Behrens). This may be the ♂ of *californicus*.

***Platylabus californicus*, Cresson (Trans. Am. Ent. Soc., vi. 201).**

♂.—Ferruginous, shining; anterior, and sometimes posterior, orbits more or less white; occiput sometimes blackish; antennae long, slender, more or less black; upper margin of prothorax sometimes narrowly white; mesothorax often varied with black; scutellum strongly margined; metathorax obliquely truncate behind, bounded above and laterally by a sharp carina, lateral angles prominent, spiniform; wings hyaline; abdomen polished, a few small punctures at base of second segment; gastrocaeli transverse, deep, nearly meeting on disk, apex of first segment rather broad, depressed, smooth, sparsely punctured. Length .35 inch.

Hab. San Zalito, California (Behrens.).

***Phygadeuon Crotchii*, n. sp.**

♂.—Robust, black, shining; mandibles, palpi and upper anterior orbits more or less ferruginous; antennae long, stout, a broad white annulus on middle, third joint rather more than twice longer than broad, and equal with fourth; mesothorax finely punctured; scutellum triangular, flat, sparsely punctured; metathorax opaque, densely sculptured, not areolated, broadly excavated behind, lateral angles prominent, tuberculiform; tegulae ferruginous; wings yellowish-hyaline; legs subrobust, ferruginous, coxae, trochanters, posterior femora except base, and tips of their tibiae black, anterior tibiae yellowish; abdomen depressed, smooth and polished, apex of first, and second segment entirely, ferruginous; first segment robust, broad at apex; ovipositor short. Length .39 inch.

Hab. Lake Lahache, British Columbia (G. D. Crotch). A very distinct species.

Phygadeuon albirictus, n. sp.

♂.—Black; head buccate, cheeks swollen; mandibles, palpi, scape beneath and tegulæ, white; wings hyaline, iridescent; metathorax areolated; anterior legs, and four posterior tibiæ ferruginous, four anterior trochanters pale, tips of posterior tibiæ blackish; abdomen shining, impunctured, first and base of second segment finely aciculate, narrow apical margin of second, and most of third segment pale ferruginous; first segment narrow, slightly wider towards apex. Length .20 inch.

Hab. California (H. Edwards).

Phygadeuon limatus, n. sp.

♀.—Black, shining; head scarcely buccate; mandibles, antennæ at base, tegulæ, legs and abdomen, except first segment, ferruginous; palpi pale; antennæ slender, basal joints of flagellum slender, cylindrical; metathorax strongly areolated, excavated behind, with prominent lateral angles; wings hyaline, areolet quite small, 5-angular; legs slender, posterior tarsi blackish; abdomen ovate, convex, smooth, polished, impunctured, first segment gradually dilated to apex, with prominent lateral tubercles behind the middle, apex narrower than base of second segment; ovipositor about half the length of abdomen. Length .25 inch.

Hab. California (H. Edwards).

Phygadeuon crassipes, Provancher (Nat. Can. ix., p. 11).

♀.—Robust, black; clypeus, mandibles, palpi, antennæ except

antennæ long; metathorax strongly areolated, truncate behind; wings smoky; legs subrobust; abdomen elongate, shining, impunctured, first segment blackish at base, strongly bicarinate before apex, which is a little narrower than base of second segment; apical segment black. Length .25 inch.

Hab. California (H. Edwards). This may be the ♂ of *crassipes*.

***Phygadeuon fulvoscons*, n. sp.**

♀.—Shining, fulvo-ferruginous; apical half of antennæ black, third joint rather more than twice longer than wide, and longer than fourth; cheeks, mesothorax, and scutellum polished, impunctured; metathorax subopaque, not areolated, deeply excavated behind, lateral angles prominent, the carina being sharp, a triangular rugose space on summit; sutures of thorax beneath more or less black; wings smoky, stigma fulvous; legs subrobust, tibiæ smooth; abdomen polished, impunctured, apex of first segment gradually dilated to tip, which is moderately broad; ovipositor short. Length .35 inch.

Hab. California (H. Edwards).

***Cryptus proximus*, Cresson (Proc. Ent. Soc., Phila., iii. p. 290).**

♂.—Black, legs except coxæ ferruginous; wings violaceous, black; abdomen with a bluish tinge; all the coxæ slender, simple; antennæ setaceous, very slender. Length .65 inch.

Hab. Vancouver's Island (H. Edwards). Differs from Colorado specimens only by the darker wings.

♂ var.? *perplexus*.—Scape beneath, spot on mandibles and the legs, including coxæ and trochanters, brown-ferruginous.

Hab. California (H. Edwards).

***Cryptus dirus*, n. sp.**

♂.—Black; abdomen except first segment ferruginous; anterior legs tinged with ferruginous; antennæ slender, fourth joint about two-thirds the length of third; a short narrow pale line on posterior orbits; prothorax, pleura, and metathorax rugose; mesothorax finely punctured; wings fuliginous, areolet moderate, side nervures slightly oblique; tarsi simple; abdomen shining, impunctured; ovipositor nearly as long as abdomen. Length .43 inch.

Hab.—California (H. Edwards).

***Cryptus relativus*, n. sp.**

♀.—Black; legs except coxæ, trochanters, posterior tibiæ, and

tarsi, and abdomen except first segment more or less, ferruginous; line or spot on anterior orbits and posterior orbits narrowly whitish; antennæ setaceous, very slender, the fourth joint about three-fourths the length of third, which is long and cylindrical; mesothorax with deeply impressed longitudinal lines, shining, confusedly punctured; prothorax, pleura, and metathorax opaque, rugose, obliquely so on sides of metathorax, which is truncate behind, with prominent subacute lateral angles, disk with a subtriangular, ill-defined inclosure; wings fuscous or fuliginous, areolet moderate, with side nervures slightly oblique; legs slender, the joints of the four anterior tarsi dilated and spinose, posterior tarsi fuscous; abdomen impunctate, with first segment slender at base, gradually and slightly dilated to apex, bicarinate on disk, black, the apex sometimes ferruginous; ovipositor two-thirds the length of abdomen. Length .55 inch.

Hab. British Columbia (Crotch). Closely related to *robustus* Cres., from Colorado, which also has the four anterior tarsi dilated, but has all the tibiae ferruginous, the abdomen black, with the apex only sometimes ferruginous.

Cryptus platifrons, n. sp.

♂.—Black; four anterior legs except coxæ and trochanters, posterior femora and the abdomen except first segment fusco-ferruginous; anterior orbits, broad on face, line on posterior orbits, spot on clypeus and spot on mandibles, white; mesothorax and scutellum shining, rest of thorax rugose, opaque; a well-defined arcuated carina across metathorax on verge of truncation, and

abdominal segment broad, nearly quadrate, the sides being straight, ovipositor long. Length .45-.70 inch.

Hab. Fort Tejon, California (H. Edwards, Crotch).

***Cryptus pacificus*, n. sp.**

♂.—Black: legs including coxæ and abdomen entirely, ferruginous: orbits, interrupted behind summit of eyes, spot on middle of face, clypeus, spot of mandibles and palpi, whitish: antennæ long, scape beneath sometimes tinged with red; tegulæ reddish in front; mesothorax and scutellum shining, the former with two deeply impressed lines; metathorax rugose, with two irregular, wavy, transverse carinæ, somewhat confused on the disk, lateral angles subacute; wings hyaline, apical margins narrowly dusky, areolet moderate, broad, nearly quadrate; legs long, slender, posterior tibiæ dusky, their tarsi whitish beyond first joint, sometimes the anterior coxæ and the four anterior trochanters beneath are pale; abdomen long, slender, especially at base, shining, impunctate, the first segment slightly widened towards tip, lateral tubercles prominent, behind which the upper surface is somewhat sulcate. Length .45-.65 inch.

Hab. California (H. Edwards).

***Cryptus latus*, Provancher Nat. Can. vi. p. 204.**

♂.—Small, black: antennæ with a white annulus; four anterior legs except coxæ and trochanters, posterior femora except tips, black; the three basal segments of abdomen ferruginous; wings fuscoglymate; base of posterior tibiæ and of the first, and more of the second, joint of their tarsi, also of the tibial spurs, white; a white spot at apex of abdomen; ovipositor as long as abdomen. Length .25 inch.

Hab. British Columbia (Crotch).

***Cryptus atriceps*, n. sp.**

♂.—Fulvo-ferruginous: head entirely black; palpi pale; antennæ black beyond the fifth joint, joints 8-10 white above, third joint very long, about one-fifth longer than fourth; sutures of coxæ more or less black; impressed lines of mesothorax black entirely; a line or spot on upper margin of prothorax, tegulæ, axel of scutellum and spot on postscutellum, white; metathorax fuscoglymate, a well-defined transverse carina before the mid-lateral angles small, spiniform; wings fuscoglymate, areolet polygonal; tips of posterior tibiæ and of their tarsi dusky,

second and third joints of the latter white; abdomen robust, minutely punctured on second segment, apex of first segment dilated; apex of abdomen dusky, ovipositor long. Length .25 inch.

Hab. Great Salt Lake, Utah.

Cryptus calipterus, Say (Bost. Journ. Nat. Hist., i p. 234).

♀.—Ferruginous; antennæ except base, tips of posterior tibiæ and band at base of third abdominal segment, black; head narrow, cheeks flat; third joint of antennæ about four times longer than broad, and equal with fourth; wings yellow with three broad fuliginous bands, the apical one broadest and confluent beneath with the middle band, leaving a triangular yellow spot beyond areolet, which is small and nearly quadrate; ovipositor longer than abdomen. Length .50 inch.

Hab. California (Stretch), Utah. The specimen from the last locality is paler ferruginous, with tip only of antennæ black, and the fuscous bands on wings quite narrow.

Cryptus Crotchii, n. sp.

♀.—Robust, fulvo-ferruginous; head subbuccate; antennæ black at tips, third joint rather more than three times longer than broad, and equal with fourth; mesothorax and scutellum shining, minutely punctured; pleura confluent punctured, opaque; metathorax rugose, opaque, an arched transverse carina above posterior truncation; wings yellow, marked as in *calipterus*, areolet small, nearly quadrate; tips of posterior tibiæ black, tarsi strongly setose beneath, abdomen opaque, minutely punctate, a black band at

Cryptus turbatus, n. sp.

♂.—Size and sculpture of *Crotchii*, but of a darker ferruginous color; apex of antennæ, sutures of thorax, tip of posterior tibiae, and band at base of third abdominal segment, black; metathorax scabrous, rounded, subtruncate behind, with a short oblique carina on each side; wings fuliginous, a paler patch immediately before and behind stigma, areolet small, quadrate; otherwise as in *Crotchii*. Length .60 inch.

Hab. California (Stretch). This may prove to be only a dark-winged variety of *Crotchii*.

Cryptus resolutus, n. sp.

♂.—Fulvo-ferruginous; head black, sides of face, spot on mid-die, clypeus and labrum yellow; orbits very broad behind eyes, but narrowed beneath, palpi and scape beneath fulvous; remainder of antennæ black; prothorax except upper margin, whole of pleura, broad stripe on anterior middle of mesothorax, lateral region of scutellum, basal margin of metathorax and the flanks, black; mesothorax shining, sparsely punctured; scutellum elongate, flattened, polished; metathorax rounded, depressed above, pubescent, without transverse carinae; wings fusco-hyaline, darker at tips; the coxæ, except posterior pair above, stripe on posterior femora beneath and tips of their tibiae black; abdomen slender, especially at base, smooth and polished, basal margin of second and following segments more or less black, first segment slightly broader at tip. Length .55 inch.

Hab. California (H. Edwards).

Cryptus Edwardii, n. sp.

♂.—Ferruginous, shining; head buccate, cheeks swollen; antennæ unusually short, third, fourth, and fifth joints each rather more than twice longer than broad, sixth joint quadrate, remainder transverse, apical joints black; sides of thorax and legs with sparse glittering hairs; mesothorax with a few scattering large punctures; pleura sparsely punctured; metathorax obsoletely sculptured, destitute of carinae, the flanks smooth and shining, posterior face with a broad shallow excavation, sides rounded; wings fuliginous or generally fusco-hyaline, darker on apical margins, sometimes yellowish-hyaline, subfasciate with fuscous, areolet moderate, subquadrate; legs robust, the femora somewhat swollen, four anterior tarsi with dilated, spinose joints, the inter-

mediate tibiae densely spinose; abdomen robust, impunctured, apex of first segment rather broadly dilated, base of third segment narrowly black; ovipositor about as long as abdomen. Length .40-.60 inch.

Hab. California (H. Edwards); Wilmington, Cal. (Crotch). Very distinct by the form of antennae and legs. The color of the wings varies greatly.

Cryptus panisus, n. sp.

♀.—Dark rufo-ferruginous, shining; head long, narrow, subtriangular in front, cheeks flat, polished; antennae long, setaceous, very slender, black, scape ferruginous; mesothorax and scute smooth and polished, with a few scattering punctures, the two longitudinal impressed lines on mesothorax very deep; prothorax and pleura opaque, finely rugose, obliquely so on pleura; mesothorax rugose, opaque, truncate behind, the verge with a sharp carina, ending on each side in a short stout spine, disk with a subtriangular inclosed space; wings dark fuliginous, violaceous, areolet moderate, subquadrate; legs slender, tarsi slender and simple, posterior tibiae more or less fuscous, middle of their tarsi pale; abdomen shining, impunctured, first segment with moderately dilated apex, before which the disk is strongly bicarinate; ovipositor two-thirds the length of abdomen. Length .55 inch.

♂.—Very slender; dark ferruginous; shining; a broad and

than broad; mesothorax convex, sparsely and finely punctured, with a few scattering larger punctures; pleura and flanks of metathorax finely punctured, shining; upper portion of metathorax finely shagreened, subopaque, rounded, without carinæ, except on verge of the posterior truncation; wings blackish-fuliginous, strongly violaceous, areolet small, nearly quadrate; legs rather slender, tarsi simple; abdomen swollen beyond first segment, polished, impunctured, apex of first segment dilated, disk of first and second segments with a shallow depression; ovipositor as long as abdomen. Length .55 inch.

Hab. California (H. Edwards). Resembles *punicus* very much in color, but the head is more buccate, the antennæ more robust, with shorter joints and differently colored; the sculpture of the thorax and shape of the abdomen are entirely different.

***Linocera Edwardsii*, n. sp.**

♂.—Black: face, clypeus, labrum, mandibles, palpi, upper anterior orbits, line on posterior orbits, scape beneath, tegulae, spot beneath, and the scutellums, pale lemon-yellow; antennæ orange-yellow, black at extreme tips; wings hyaline, tinged with yellow, extreme apical margins fuscous; legs yellow, very slender, posterior pair very long, posterior coxæ, base of their trochanters above and their femora except base, and tips of their tibiae beneath, black; abdomen very slender, lemon-yellow, base of second and following segments broadly black, also a black spot on apex of first segment between tubercles and tip. Length .55 inch.

Hab. California (H. Edwards). A very handsome species.

***Neostenus gracilipes*, n. sp.**

♂.—Elongate, narrow, shining, uniformly fulvous; tips of mandibles, antennæ, except scape and third joint beneath, and extreme base of posterior tibiae black; antennæ long and slender; mesothorax prominently trilobed, sparsely punctured; metathorax obliquely depressed behind, rugulose, with an angulate carina at base, anterior to which the surface is smooth and shining; wings fuscous, areolet long and very narrow; legs long and very slender, especially the posterior pair, the trochanters of which are half the length of the femora, the posterior trochanter about double the length of the anterior one; abdomen polished, first segment long, slightly swollen at tip, base of second segment considerably

contracted; ovipositor very long, nearly twice the length of body. Length .46 inch, of ovipositor .90 inch.

Hab. California (H. Edwards).

Ophion costale, n. sp.

♀.—Fulvo-ferruginous, shining; face broad, the middle closely punctured, subtuberculate immediately beneath base of antennæ; clypeus strongly punctured, tips truncate, lateral sutures and tips of mandibles black; cheeks swollen; antennæ shorter than usual, reaching about to tip of second abdominal segment, mesothorax convex, polished; scutellum very convex; metathorax confluent punctured, without transverse carina, sutures of thorax narrowly black; wings subhyaline, stained with yellowish at base and with fuscous along apical costal margin, darkest at tip of marginal cell; basal margin of third and fourth abdominal segments and an oblique mark on sides of second segment, black. Length .33 inch.

Hab. Klamath Co., California (H. Edwards). Readily distinguished from all the other species known to me by the ornamentation of the wings.

Nototrachys californicus, n. sp.

♀.—Black; orbits entirely, broad beneath antennæ, sides of clypeus, mandibles, palpi, short stripe on each side of mesothorax, tegulæ, spot before, another beneath, and spot on scutellum, red. Sometimes suffused with sanguineous; antennæ brown; legs

ish; spot on each side of pleura posteriorly, and on flanks of metathorax ferruginous; metathorax coarsely reticulated, subconcave; wings fusco-hyaline, stained with yellowish, stigma and costal nerve honey-yellow; legs yellow, all the coxæ, apical half of posterior femora and apical third of their tibiæ, black; abdomen honey-yellow, polished, basal two-thirds of upper edge of second segment, stripe on each side of fourth segment, and the following segments entirely black. Length .70 inch.

Hab. Oregon (H. Edwards). This also occurs in Colorado.

***Asomalon Edwardsii*, n. sp.**

♂.—Ferruginous, head and thorax clothed with a short pale sericeous pubescence; head short, broad, yellow, vertex, occiput, and posterior margin of cheeks black, upper part of cheeks tinged with ferruginous; a transverse prominence immediately beneath insertion of antennæ; antennæ two-thirds the length of body, fulvous, darker above, first, second, and base of third joints black above and yellow beneath; three broad stripes on mesothorax, the lateral ones confluent behind, prothorax anteriorly, pleura, except anterior margin, and base of metathorax, black; metathorax very coarsely reticulated; wings fusco-hyaline, darker beyond stigma which is fulvous, discoidal cell very slightly narrowed at base; four anterior legs honey-yellow, tibiæ and tarsi paler; posterior legs black, second trochanter and extreme base of femora ferruginous, basal half of tibiæ and the tarsi, except terminal joint, yellow, tarsi thickened, the first joint nearly three times longer than second, abdomen shining, ferruginous, apex of first broad, upper edge of second, and the fifth and sixth segments entirely black, sides of third and fourth varied with fuscous. Length .85 inch.

Hab. Vancouver's Island (Henry Edwards).

***Asomalon californicum*, n. sp.**

♂.—Ferruginous, head and thorax clothed with short brownish pubescence; face, orbits, and clypeus yellow, spot inclosing ocelli black, antennæ short, stout, about half the length of body, scape yellow beneath; sutures of thorax narrowly black; mesothorax shining, sparsely punctured; scutellum gibbous, slightly furrowed down the middle; metathorax coarsely reticulated, depressed and subconcave above; wings tinged with yellowish-fuscous, darker at tips, discoidal cell not narrowed at base; four anterior legs honey-yellow, posterior pair fulvous, with tips of femora and of

tibiæ black, tarsi yellow, thickened, first joint twice the length of second; abdomen shining, basal half of upper edge of second segment and upper edge of fifth and sixth segments black, lower margin of apical segments tinged with blackish. Length .65 inch.

Hab. California (H. Edwards).

Anomalox verborum, n. sp.

♂ ♀.—Black; head large, face narrowed beneath; narrow orbital line on each side of face, dot at summit of eyes, spot beneath eyes and mandibles except tips, yellowish; antennæ short, about as long as head and thorax together, entirely black; thorax immaculate; metathorax reticulated, grooved down the middle; wings fusco-hyaline, discoidal cell very much contracted at base; legs rufo-ferruginous, coxæ and trochanters black, posterior tibiæ fuscous in ♀, their tarsi blackish in ♀ with basal joint slightly thickened, and in ♂ with second and third joints ferruginous and basal joint dilated; abdomen yellowish-ferruginous, upper edge of second segment and the fifth and following segments black, sometimes only the apex of fifth segment is black. Length .40 inch.

Hab. California (H. Edwards).

Anomalox maceratum, n. sp.

♂.—Black; head and thorax clothed with short pale pubescence; head not wider than thorax, cheeks prominent; orbits, face, clypeus, labrum, mandibles except tips, palpi and scape beneath, yellow; antennæ about half the length of body; posterior middle of mesothorax depressed and transversely rugose; prothorax and

the length of body, black, brown beneath, scape yellow beneath; mesothorax in front and pleura beneath black; metathorax reticulated, deeply sulcate down the middle, with a short arcuated carina on each side near base; wings yellowish-hyaline, discoidal cell slightly narrowed at base; tips of posterior tibiae dusky, their tarsi slender, yellowish; abdomen shining, with upper edge of second and following segments narrowly black. Length .50 inch.

Hab. Oregon (H. Edwards).

Campoplex major, n. sp.

♂.—Black, opaque, clothed with short whitish pubescence, more dense on face and metathorax; mandibles, palpi and tegulae lemon-yellow; a tuft of long pale pubescence on each side of scutellum; middle of metathorax longitudinally concave and transversely aciculated; wings hyaline, tinged with yellowish, a little smoky at tips, areolet large, rhomboidal; anterior legs except base of coxae and trochanters and femora beneath, intermediate trochanters and femora above, their tibiae and tarsi entirely, and a stripe on outer side of posterior tibiae, lemon-yellow; four anterior ungues black; abdomen shining, ferruginous, base of first segment, its apex above, upper surface of second segment and apex of third, black. Length .75 inch.

Hab. Vancouver's Island (H. Edwards). A fine large species.

Lixaria californica, n. sp.

♂.—Black, shining; mandibles, palpi, scape beneath, and tegulae yellow, flagellum testaceous beneath towards the tip; metathorax transversely rugulose behind; wings hyaline, iridescent, areolet stalk petiolated; legs fulvo-ferruginous, four anterior coxae, and also the trochanters yellow, base of posterior tibiae and of their tarsi yellowish, posterior coxae and base of their trochanters black, narrow apical margin of second abdominal segment and apex of half of third ferruginous. Length .30 inch.

Hab. San Diego, California (Crotch).

Mesochorus iridescent, n. sp.

♂.—Luteo-testaceous, polished; tips of mandibles, spot behind antenna, back of head, three broad stripes on mesothorax, broad transverse base of metathorax, pleura beneath, and first abdominal segment except tip, black; antennae long and slender, fuscous, black at base, scape beneath luteous; tegulae white; wings hyaline, beautifully iridescent; legs pale, tips of posterior tibiae and of

their tarsi blackish; sides of second abdominal segment and the apical segments more or less stained with fuscous. Length .25 inch.

Hab. California (Behrens).

Pristomerus pacificus, n. sp.

♀.—Black; orbits and clypeus ferruginous, mandibles yellow, antennæ entirely black; tegulæ yellow; wings hyaline, iridescent; legs, including coxæ, ferruginous, anterior pair paler, posterior trochanters, tips of their tibiæ and their tarsi more or less dusky, femoral tooth robust; abdomen polished, ferruginous, first segment except apical margin, basal two-thirds of second, and base of remaining segments more or less black; ovipositor three-fourths the length of abdomen. Length .30 inch.

Hab. California (H. Edwards).

Exetastes maurus, n. sp.

♀.—Entirely black, shining, robust; head and thorax clothed with short black pubescence; antennæ tinged with brown; mesothorax strongly and rather closely punctured; scutellum gibbous, coarsely punctured; metathorax coarsely rugose, opaque; wings dark fuscous, paler towards tips, violaceous; abdomen short, robust, polished, impunctured. Length .45 inch.

Hab. California (H. Edwards).

Exetastes zelotypus, n. sp.

♂ ♀.—Black, shining; thorax closely and finely punctured, metathorax finely rugose; wings fuliginous, strongly violaceous; tips of anterior femora and tibiæ and posterior femora ♀, four

or less varied with fulvous; abdomen fulvo-ferruginous, the first segment, except a stripe above and spot at tip above, and also spot on each side of all the segments becoming larger on apical segments, yellow. Length .70 inch.

Hab. California (H. Edwards).

***Neoleptus innoxius*, n. sp.**

♂.—Honey-yellow; face, clypeus, mandibles, except tips and palpi, tegulae, spot before and spot beneath, pale yellow; antennae long and slender, dusky at extreme tips; large spot on pleura beneath, and sides and tips of metathorax more or less black; wings hyaline, iridescent, stigma luteous, areolet small, petiolated; legs long and slender, four anterior coxae and trochanters pale yellow; abdomen dark honey-yellow or fulvous, base of first segment black, apical segments more or less varied with dusky; first segment straight, not slender at base and slightly dilated to apex, lateral tubercles large and prominent. Length .30 inch.

Hab. Lake Quesnel, British Columbia (Crotch).

***Neoleius Stretchii*, n. sp.**

♂.—Opaque black; head rather swollen behind the eyes; clypeus, mandibles except tips and scape beneath luteous; sides of mesothorax tinged with dull ferruginous; metathorax with an elongate central area; tegulae yellowish white; wings hyaline, iridescent, stigma luteous, areolet small, triangular, subpetiolated; legs slender, and with coxae, pale ferruginous, four anterior coxae beneath and their trochanters yellow; tips of four anterior tarsi and posterior pair more or less fuscous; abdomen sculptured, finely and densely sculptured, depressed at base, first segment very slightly curved, gradually dilated to tip which is broad, upper surface flat and even, the lateral margin finely carinate, sides of apex yellow; lateral margin, broad at tip and with a narrow apical margin of all the segments.—sometimes indistinct on second and third, pale yellow; second and third segments sometimes tinged with brown. Length .27 inch.

Hab. California (Stretch).

***Neoleius? alontianus*, n. sp.**

♂.—Slender, black, head and thorax with short pale pubescence; head short, subbuccate; antennae long, curved at tip, metathorax flat and declivous behind, with carinate sides; scutellum longitudinally compressed, convex above; metathorax roughened,

subsulcate on each side of middle, spiracles small, circular; tegæ whitish; wings hyaline, beautifully iridescent, stigma rather fuscous, areolet 5-angular, with thickened nervures; legs long and very slender, ferruginous, coxæ and trochanters black, tips of posterior femora, their tibiæ and tarsi more or less dusky; abdomen sessile, slightly widened to tip, spiracles placed a little above the middle. Length .30 inch.

Hab. Aleutian Islands (H. Edwards).

Mesoleius ? lætus, n. sp.

♂.—Black; face, clypeus, mandibles except tips, palpi, scape beneath, spot on each side of mesothorax in front divided by a depressed line, spot behind anterior coxæ, tegulæ, short line beneath four anterior coxæ, trochanters, femora and tibiæ, posterior trochanters, extreme base of their femora, basal two-thirds of the tibiæ, and abdomen except two apical segments, all pale yellow; apex of flagellum fulvous beneath; wings yellowish hyaline, areolet; legs slender, all the tibiæ honey-yellow, claws simple; abdomen subpetiolated, subclavate, being gradually broader to tip, the first and fourth and fifth segments often stained with fulvous. Length .35 inch.

Hab. Vancouver's Island (H. Edwards).

Mesoleius ? rubiginosus, n. sp.

♂.—Fulvous; face, clypeus, mandibles except tips (which are black), small spot on scape beneath, tegulæ, short line beneath

densely sculptured, opaque; first segment broad, with two strongly elevated longitudinal carinae on middle extending to the tip. Length .25 inch.

Hab. Fort Tejon, California (Crotch).

***Tryphon lasorius*, n. sp.**

♂.—Black, rather shining, clothed with a short pale sericeous pubescence; apex of clypeus, mandibles and tegulae yellow; antennae pale beneath at tip; wings hyaline, iridescent, stigma fuscous, pale at base, areolet small, rhomboidal, petiolated; four anterior legs yellow, coxae, trochanters and femora beneath black; posterior femora robust, ferruginous, black at base beneath and at extreme tip, coxae, trochanters, tibiae and tarsi black or fuscous, the tibiae above with a yellow stripe extending from base nearly to tip, claws simple; abdomen subclavate, ferruginous, the first segment entirely, second except apex, and base more or less of remaining segments black; first segment slightly narrowed at base, not carinate above. Length .25 inch.

Hab. California (H. Edwards).

***Tryphon californicus*, n. sp.**

♂.—Black, shining, clypeus, mandibles, palpi and tegulae yellow, head rather broad; face with an elevated, flattened, strongly notched space on the middle; metathorax with two approximate longitudinal carinae on disk, two on each side and a circular one in the center; scutellum convex, deeply excavated at base; wings hyaline, areolet small, oblique, petiolated; legs robust, fulvo-ferruginous, coxae and trochanters black, four anterior tibiae and tarsi black, tips of posterior femora, their tibiae and tarsi more or less fuscous or black; abdomen ferruginous or fulvous, sometimes black, ferruginous, in ♂ the first segment only is black with apical black, in ♀ the first and often more or less of the second and third segments black; first segment at base narrow, not carinate. Length .20 inch.

Hab. San Diego, California (Crotch).

***Exochus obscurellus*, n. sp.**

♂.—Black, shining; head broad; face broad and flattened, densely sculptured; spot on mandibles and palpi dull testaceous; thorax minutely punctured; scutellum convex; metathorax with two strongly elevated lines; wings hyaline, areolet oblique, subtriangular; legs subrobust, black, tips of femora, a line on poste-

rior pair above, and all the tibiae and tarsi ferruginous, tips of posterior tibiae and tarsi dusky; claws pectinated; abdomen subsessile, subcompressed at tip, first segment broad at tip, and strongly narrowed behind the tubercles, apex of second and the third and following segments more or less ferruginous. Length .30 inch.

Hab. California (H. Edwards).

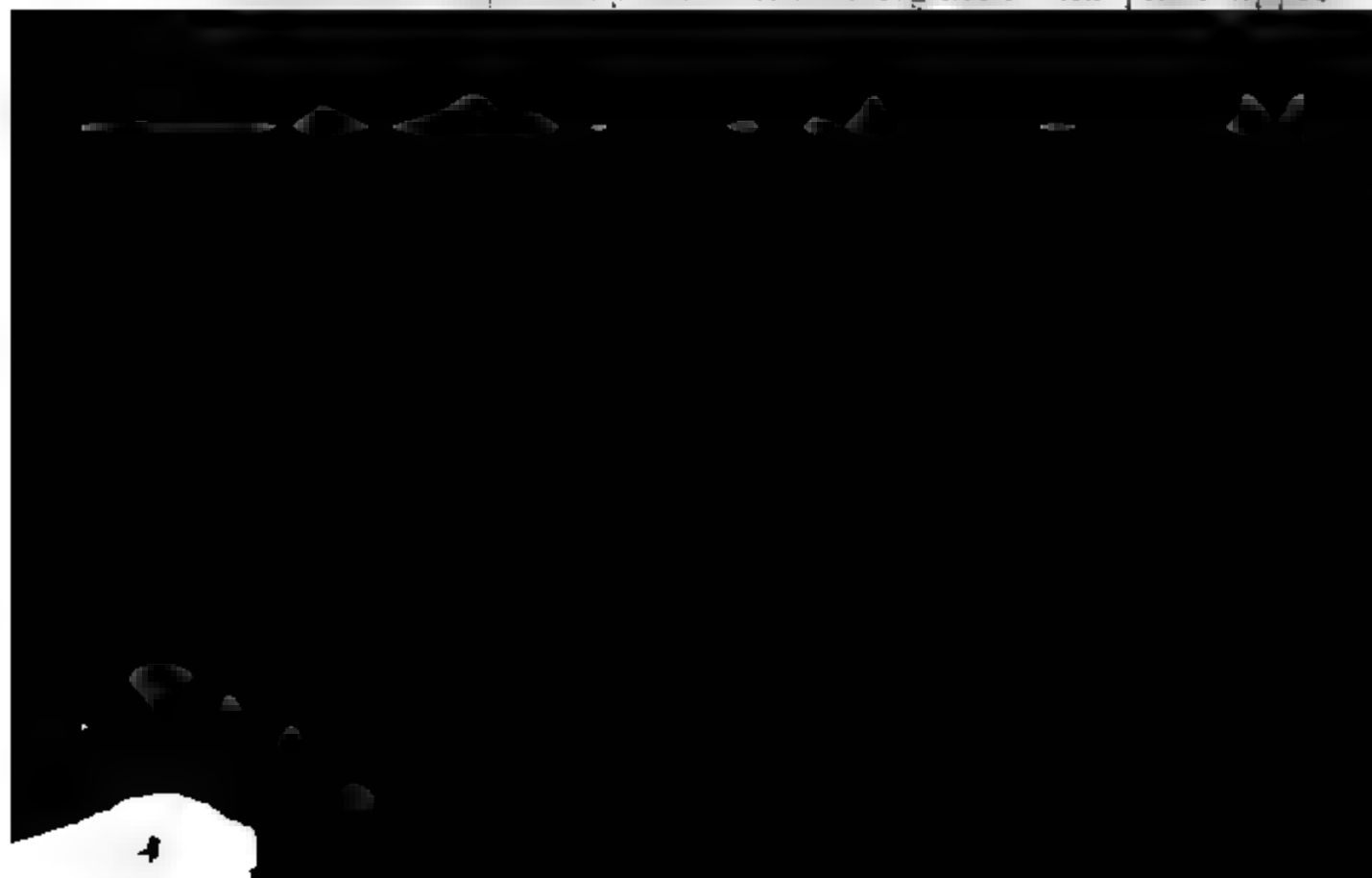
Ctenistes californicus, n. sp.

♂.—Black, clothed with a short fine pale pubescence; face, clypeus, mandibles, palpi, lower part of cheeks, scape beneath, sides of collar, tegulae, spot before, another beneath, spot on anterior margin of pleura, tip of scutellum, lateral apical margin, post-scutellum, four anterior coxae and the trochanters, and apical margin of second and following segments of abdomen, all white; flagellum luteous beneath; broad stripe on each side of mesothorax, scutellum, and pleura ferruginous; wings hyaline, iridescent, areolet present; legs fulvous, tips of posterior femora, their tibiae and tarsi black; claws pectinate; abdomen subclavate, sessile, the white bands broader on apical segments. Length .22 inch.

Hab. California (H. Edwards). A handsomely marked species.

Exochus brunripes, n. sp.

♀.—Small, black, smooth, and polished, impunctured; antennae brown; metathorax with conical central area; tegulae pale brownish; wings hyaline, areolet present; legs short, robust, brownish-fulvous, femora very much swollen, coxae, trochanters and femora beneath black, posterior tibiae and tarsi fuscous, paler at base; abdomen above perfectly smooth, first segment with plate upper



on each side, and four anterior coxæ and trochanters, white or yellowish-white: otherwise marked as in ♀, except that the mark before tegulae is large and cuneiform, and the lateral spots on abdomen are sometimes connected by a narrow line on apical margin of the segments. Length .27 inch.

Hab. California (Behrens, ♀; H. Edwards, ♂). This pretty species occurs also in Colorado.

***Dacnusa cinetulus*, n. sp.**

♂.—Black: face, anterior orbits, lower part of cheeks, clypeus, mandibles except tips, scape beneath, two longitudinal stripes on mesothorax, the lateral margin before tegulae, broad stripe on scutellum, postscutellum, tegulae, spot before, short line beneath, anterior margin of pleura, trifurcate mark beneath, sutural line between pleura and metathorax, narrow line on tip of first segment of abdomen not reaching the side, rather broad band at tip of second, third, and fourth segments, and spot on each side at base of fourth segment, all white; wings hyaline, areolet wanting; legs fulvous, four anterior coxæ, tips of posterior pair, all the trochanters, four anterior legs in front, and broad streaks on posterior tibiae white; extreme base and apical third of posterior tibiae black, their tarsi ———; base of abdomen rugose, punctured, apex shining, a transverse impressed line on second and third segments. Length .22 inch.

Hab. California (H. Edwards). Easily recognized by the two distinct white stripes on mesothorax and white bands on abdomen.

***Dacnusa decoratus*, n. sp.**

♂.—Black: face, anterior orbits, lower parts of cheeks, clypeus, mandibles, palpi, scape beneath, two stripes on mesothorax abbreviated behind and confluent anteriorly with broad lateral margins of scutellum, postscutellum with line on each side extending to base of wings, narrow anterior margin of pleura, transverse line on each side, sutural line between pleura and metathorax, tegulae, spot before and another beneath, all pale yellow; wings hyaline, areolet present; legs pale fulvous, all the coxæ and trochanters white, posterior coxæ black at base beneath, posterior tarsi black; abdomen shining, with first and base of second segments rough and dull, no transverse impressed lines; apical half of second segment, the third and apical half of fourth fulvous, a yellowish band at base of third segment interrupted

medially, basal margin of fourth segment narrowly pale yellow, broadly margined behind with black. Length .23 inch.

Hab. California (H. Edwards)

Basus pacifens, n. sp.

♂ ♀.—Black; spot on middle of face, clypeus, mandibles, palpi, broad lateral margin of mesothorax hooked in front, tegulæ, spot before and one beneath, pale yellowish; wings hyaline, iridescent, areolet wanting; four anterior coxæ except base, their trochanters and tips of posterior coxæ white, remainder of coxæ black, femora, tibiæ, and four anterior tarsi fulvous, posterior tarsi blackish; abdomen ♀ subcompressed at tip and shining, no transverse impressed lines, first and second segments roughly sculptured, apex of second, the third, and more or less of fourth segments ferruginous. Length .23-.25 inch.

Hab. California, ♀; Vancouver's Island, ♂ (H. Edwards).

Metopius Edwardsii, n. sp.

♂.—Short, robust, black, opaque, roughly sculptured; face, anterior orbits, labrum, palpi, scape beneath, upper margin of prothorax, narrow apical margin of scutellum, spot on each side of metathorax, spot at tip of four anterior coxæ, all the trochanters, four anterior femora in front, base and apex of posterior pair, all the tibiæ, four anterior tarsi, and base of posterior pair, first abdominal segment except base, spot on each side of second segment at tip and apical margin of remaining segments broader on third and fourth, all yellowish-white; thorax closely and strongly punctured; wings subhyaline, tinged with fuscous especially along



ments above, black; ovipositor as long as body. Length .85 inch.

Hab. Vancouver's Island (H. Edwards).

***Ephialtes thoracicus*, n. sp.**

♂. — Black; tip of clypeus, mandibles, and scape beneath, brown; face with short pale pubescence, clypeus with long pale hairs; palpi whitish; mesothorax, scutellum, pleura, and flanks of metathorax ferruginous; middle lobe of mesothorax gibbous, very prominent, smooth; metathorax finely rugulose, clothed with short pale pubescence; lower margin of prothorax and tegulae white; wings hyaline, iridescent, areolet small, triangular, subpetiolated; legs very slender, the anterior pair entirely, middle trochanters, femora, and tibiae, pale yellow, middle coxae, honey-yellow, pale beneath, their tarsi blackish, posterior coxae, trochanters beneath and femora bright ferruginous, their trochanters above, tibiae and tarsi black; abdomen long, narrow, black, immaculate, finely sculptured; ovipositor as long as the body. Length 2.0 inch.

Hab. Vancouver's Island (H. Edwards).

***Pimpla Behrensi*, n. sp.**

♂. — Black; palpi, tegulae and spot in front white; mesothorax, scutellum, and pleura shining, the former finely and sparsely punctate; wings hyaline, iridescent; legs fulvous, anterior pair pale in front, coxae black, middle tibiae with whitish annulus; posterior tibiae black, with broad white annulus towards base, their tarsi black more or less white at base of all the joints; abdomen strongly punctured and finely pubescent, apical margin of the segments narrowly pale or ferruginous, sides of the segments with a ferruginous spot, or more or less broadly margined with ferruginous; ovipositor of ♀ short. Length .35-.40 inch.

Hab. California (Behrens). A very common species.

***Lampronota gelida*, n. sp.**

♂. — Black, clothed with short pale pubescence; face yellow, with three longitudinal black stripes, sometimes broken into spots; clypeus yellow, with basal margin or spot on each side black; mandibles except tips, and palpi, yellow; tegulae and spot before and sometimes a spot on each side of mesothorax in front, yellow; metathorax densely punctured; wings hyaline, more or less tinged with yellowish, tegulae and basal nervures pale, areolet small.

subrhomboidal, petiolated; legs fulvous, four anterior coxæ more or less beneath, their trochanters and line on their femora beneath, yellow; four anterior coxæ at base, posterior pair, and the basal trochanters black, posterior tarsi blackish; abdomen slender, ferruginous, first segment, except tip and sometimes the two or three apical segments, black. Length .45 inch.

Hab. Lake Lahache, British Columbia (Crotch).

Lampronota vivida, n. sp.

♂.—Black, clothed with a short pale pubescence; face, anterior orbits not reaching summit of eyes, clypeus, mandibles except tips, palpi, scape beneath, line on anterior lateral margin of mesothorax dilated and hooked in front, tegulæ, spot before and one beneath, pale yellow; tip of scutellum pale; wings pale yellowish hyaline, areolet subrhomboidal, petiolated; legs fulvous, four anterior coxæ and trochanters and their femora and tibiæ in front pale yellow; base of posterior coxæ more or less black, their tarsi fuscous; abdomen yellowish fulvous, first segment except apical margin, black. Length .45 inch.

Hab. Vancouver's Island (H. Edwards).

Lampronota segnis, n. sp.

♂.—Small, black; face, anterior orbits, lower part of cheeks, clypeus, mandibles, palpi, scape beneath, two slender stripes on mesothorax, confluent in front with broad lateral margin, collar, scutellum, large mark on each side of pleura, tegulæ, spot before and one beneath, and four anterior coxæ and trochanters, all yellowish-white; spot on flanks of metathorax, remainder of legs,



small, subpetiolated; legs fulvous, four anterior coxæ white, posterior tibiæ more or less, and tarsi dusky; abdomen subclavate, apical margins of segments pale fulvous, broader on terminal segments; ovipositor as long as the body. Length .25 inch.

Hab. Wilmington, California (Crotch).

***Lamproseta Edwardsii*, n. sp.**

♂.—Entirely fulvo-ferruginous; antennæ except scape, spot beneath wings, and lower margin of metathorax black; mesothorax finely punctured; metathorax confluent punctured, with a sinuate carina near apex; wings dark yellow-hyaline, stigma and basal nervures fulvous, areolet subrhomboidal, petiolated; abdomen shining, first segment sparsely punctured; ovipositor as long as the body. Length .50 inch.

Hab. Vancouver's Island (Henry Edwards).

***Lamproseta ? lugubris*, n. sp.**

♂.—Deep black, shining; head small, with flattened cheeks; antennæ long and very slender, third joint very long, and one-third longer than fourth; mesothorax prominently trilobate; metathorax opaque, with four ill-defined longitudinal elevated lines, the two middle ones approximate; wings smoky, nervures and stigma black, no areolet; legs rather slender, ferruginous, coxæ and trochanters black, claws simple; abdomen sessile, depressed, opaque at base, shining at tip, apical margins of third and following segments narrowly dull ferruginous; ovipositor as long as the body. Length .42 inch.

Hab. Lake Quesnel, British Columbia (Crotch).

***Phytodietus obscurellus*, n. sp.**

♂.—Dull black, clothed with a very short, pale, sericeous pubescence; spot beneath eyes, dot on each side of ocelli, short line on each side of base of antennæ, clypeus, mandibles, palpi, lateral anterior margin of mesothorax, tegulae, dot before and spot beneath middle of metathorax longitudinally rugose; wings hyaline, areolet, stigma black; legs, including coxæ, fulvo-ferruginous, posterior tibiæ towards tip and their tarsi dusky; abdomen shining, apical margin of second and third segments narrowly pale; ovipositor short. Length .30 inch.

Hab. California (H. Edwards).

Phytodietus californicus, n. sp.

♀.—Small, shining black; dot on each side of ocelli, clypeus mandibles except tips, palpi, tegulae and line in front, white; pleura beneath and flanks of metathorax fulvous; metathorax smooth, with a medial longitudinal groove; wings hyaline, beautifully iridescent, stigma pale; legs, with coxae, pale fulvous, anterior coxae, four anterior trochanters, knees, and apical posterior trochanter white, tips of their tibiae and the tarsi dusky; abdomen shining, apical margin of segments five and six more or less white; ovipositor about half the length of abdomen. Length .1 inch.

Hab. California (Behrens).

Xorides occidentalis, n. sp.

♀.—Black; anterior orbits not reaching summit of eyes, on mandibles, palpi, line on each side of collar before and coxae, tegulae and spot beneath posterior wings white; scapulae beneath reddish; middle of mesothorax depressed and transversely wrinkled; metathorax finely transversely sculptured above; wings hyaline, nervures and stigma black; legs, with coxae, fulviginous, line on middle tibiae, their tarsi, tips of posterior femora and their tibiae and tarsi entirely black; abdomen black, imbricate; ovipositor about as long as the body. Length .50-.70 inch.

Hab. Vancouver's Island (H. Edwards).

narrow stripe on anterior lobe of mesothorax, and the
between side lobes are black; wings hyaline, stigma black
sh spot at base; ovipositor longer than body. Length
h.

lifornia (H. Edwards). Easily distinguished from all
nown species of this genus by the uniform ferruginous
e body.

urus, n. sp.

ust, black, immaculate; head large, broad, buccate,
ntennæ with short robust joints, the third much longer
a; mesothorax and scutellum shining; metathorax
ings smoky, areolet 5-angular, stigma black; legs sub-
of four anterior femora and all the tibiæ pale, anterior
wisted nor inflated, claws simple; abdomen subfusi-
ssile, first segment rapidly narrowed to base, a deep
uncture on apical middle, base of second segment
d finely sculptured, opaque, remainder of abdomen
ipositor longer than abdomen. Length .50 inch.
toria, Vancouver's Island (Crotch).

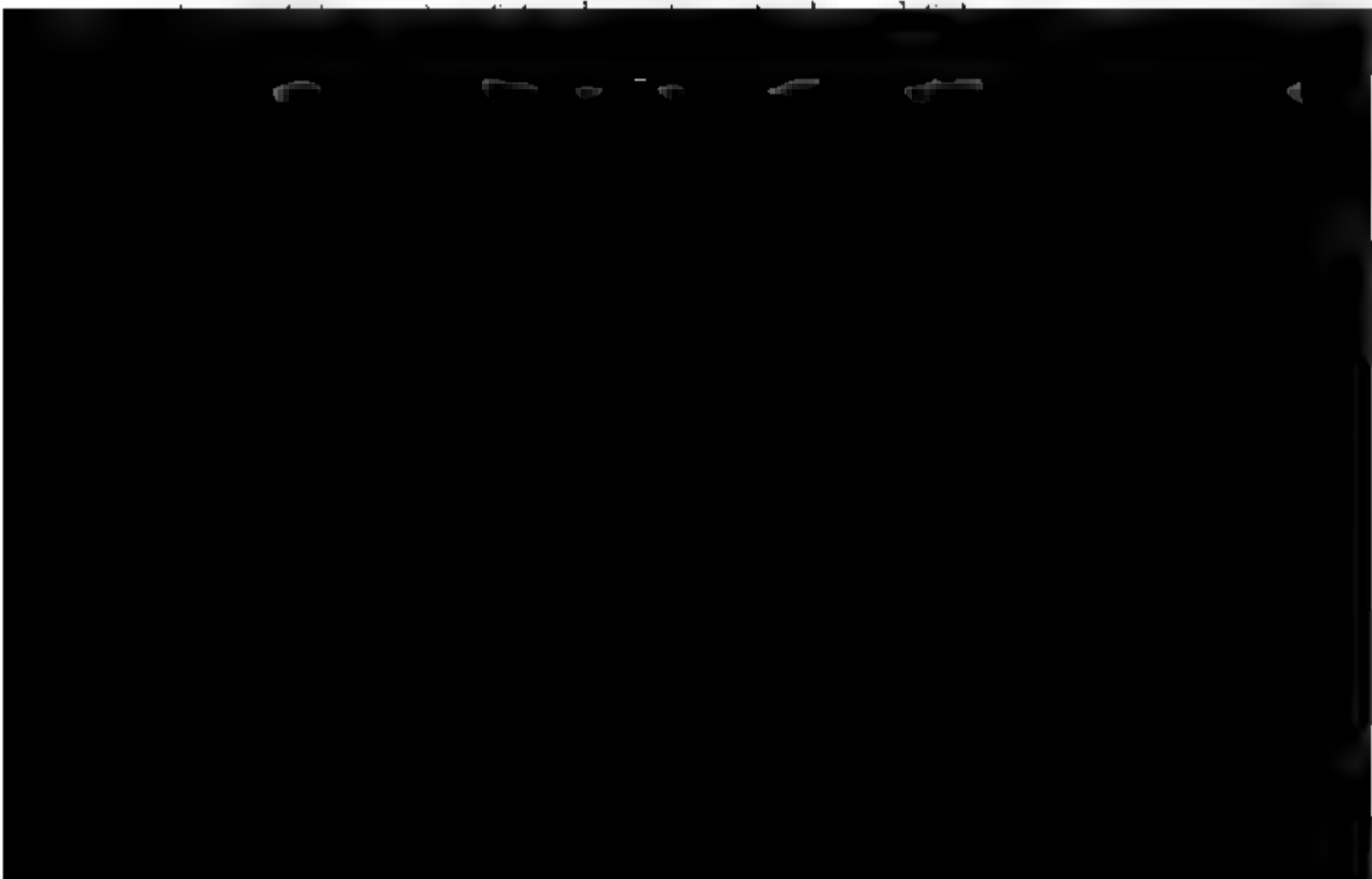
NOVEMBER 12.

The President, Dr. RUSCHENBERGER, in the chair.

Forty-eight persons present.

A paper entitled "Description of a New Species of *Dolabella*, from the Gulf of California, with remarks on other rare or little known species from the same locality," by R. E. C. Stearns, was presented for publication.

On Donax fossor.—Prof. LEIDY remarked that last July, while on a visit to Cape May, N. J., he had observed on the beach, near low tide, east of the town, in many positions, vast numbers of the little lamellibranch mollusk, *Donax fossor*, of Say. It is well named the "Digger" from the ease and rapidity with which it digs its way into the sand by means of its powerful foot. It lives in the surface sand, and is uncovered by the surf breaking on shore, but instantly buries itself again as the waves retire. In some places the little Digger was so abundant, that large patches reminded him "of barley grains lying on a malting floor," and they lay so thick as actually to interfere with one another in the attempt to bury themselves. As indicated by Mr. Say they present two varieties; one in which the shell is white, the other in which it is straw-colored. The shells generally exhibit an interior livid tint in three rays, successively widening from before backward. The rays are sometimes feeble or nearly obsolete; the anterior one is the most persistent, and the posterior one least so. The siphons are long and actively protruded and retracted, looking in their movements like wriggling worms. The Digger affords a



tioned. A small orifice occupies the median line nearly midway between the acetabula; but no appearance of generative apparatus. Length of animal in the contracted state .24 mm.; width .15 mm.; length in the elongated state to .36 and .42 mm.; width .09 mm. Oral acetabulum .072 mm.; ventral acetabulum .042 mm. The species may be named *Distomum cornifrons*.

It is probable that this little Fluke undergoes its further development in some of the shore birds or fishes which use the *Isopar fossor* as food.

The infusorian infesting the Digger is a *Trichodina*, resembling that which is found on the *Hydra* or fresh water polyp, and which is also stated by Stein to live on the gills of the Pike and the fins of the Stickleback. The Trichodine is bell-shaped, with a wreath of cils near the top, and a circle of cils at the margin beneath. It is .048 mm. broad and from .035 to .036 mm. high. Though living on a marine mollusk, it too nearly resembles the *Trichodina pediculus* of fresh-water animals for him to think of giving it another name.

Dimorphism in Mitchella repens.—MR. THOMAS MEEHAN referred to note published in the Proceedings many years ago, in regard to dimorphic flowers in *Mitchella repens*, and suggesting that the plant was practically dioecious. Three years ago he found a variety on the Wissahickon with snow-white berries; the plant, judged by the size of the patch, having been growing and bearing for many years. Some of this was removed to his garden, where, though it blossoms freely, it bears no berries, thus indicating that it was fertilized when in its wild state by the pollen from the normal scarlet berried forms in the vicinity, and that it is capable of making use of its own pollen.

NOVEMBER 19.

The President, Dr. RUSCHENBERGER, in the chair.

Forty-two persons present.

Notes of Gordius in the Cockroach and Leech.—Prof. LEMBY exhibited a Gordius, which had been submitted to him by Dr. Robert Meade Smith, of this city, with the note that "a servant killed a large cockroach (*Blatta orientalis*?) in the kitchen, and threw it into a tumbler of water, and had then noticed, as she described it, one of its legs growing and swimming off." The Gordius is nine inches long, chocolate brown, with darker spots of the same, attenuated anteriorly with the head rounded, and the tail broad and at the end slightly compressed and roundly truncated. Thickness of the worm anteriorly 1/4 of a line; posteriorly 1/2 of a line. The species is probably *Gordius aquaticus*.

Prof. L. further remarked that twenty years ago he had collected from Lily Pond, Newport, R. I., a number of little leeches, of two species of *Clepsine*, which were much infested with delicate hair-worms, coiled up in the interior of the body. The *Clepsines* were the fourth to the third of an inch in length. The most frequent of the species had two eyes, the other had three pairs of eyes. The leeches contained from one to five of the hair-worms ranging from 10 lines to 2 inches in length. The worms appear to pertain to a species of *Gordius*, which, from its slender character, may be named *Gordius tenuis*. The worm is white or cream-colored, but has become brown as preserved in alcohol. It is attenuated anteriorly, with the head end tapering and conical; the posterior end is curved, thickened, and obtusely rounded. A short oesophagus is succeeded by a simple, straight, capacious intestine imperforate at the posterior extremity. A worm of two inches in length, measured 0.06 mm. near the head end, 0.14 mm. at the middle, and 0.12 mm. at the tail end. A specimen 10 lines in length measured at the middle 0.1 mm. thick.

NOVEMBER 26.

The President, Dr. RUSCHENBERGER, in the chair.

Forty-six persons present.

A paper entitled "Note on Hyraceum," by Wm. H. Green M.D., and A. J. Parker, M.D., was presented for publication.

The deaths of Thomas H. Powers, a member, and Dr. Ben Dowler, a correspondent, were announced.



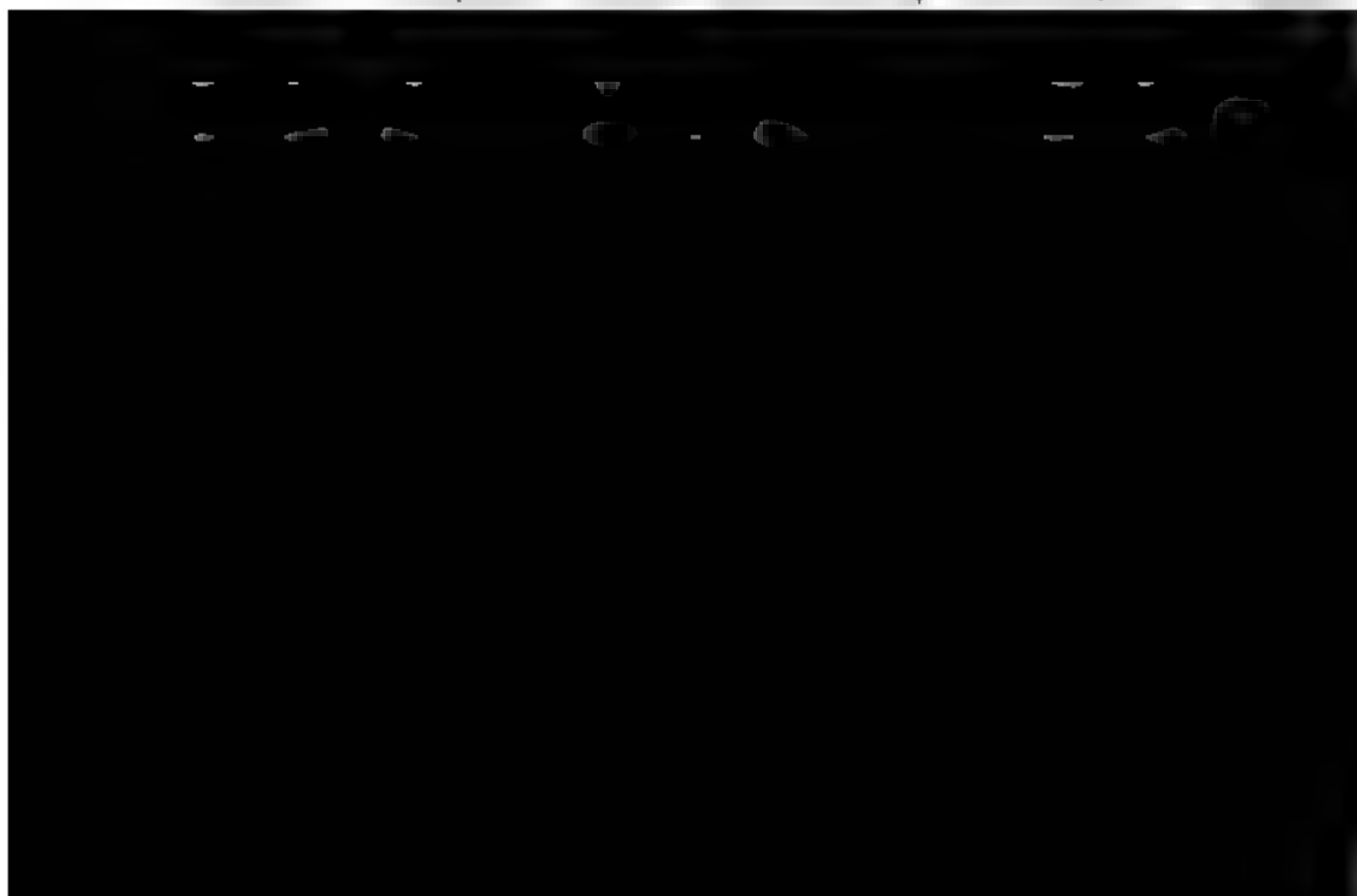
...ative, it appears to me proper to commence to say
y the results of my recent dissection of that animal, and
e more especially in what the Gorilla agrees with, and
iffers from other monkeys and man. I take great pleasure
ing my observations by stating that I am indebted to
nas Morton, of this city, for the very rare chance of dis-
specimen of *Troglodytes gorilla*, it having been seldom
oad, and never before in this country, so far as I know.
mber of years past Dr. Morton has made numerous efforts
n a Gorilla, and finally, through the kind offices of Rev.
'assau, M.D., of the Presbyterian Missionary station at
100 miles below the equator in Africa, succeeded, in the
rt of the summer, in getting to Philadelphia the subject
resent communication. The specimen was sent from the
preserved in rum, and, through the excellent precaution
assau, considering all the circumstances, was received
tolerably good condition. Owing to his numerous pro-
engagements Dr. Morton was unable to dissect the
himself, which at his request I did, with the exception
of the right leg, which Dr. Morton dissected entirely.
rks will be confined to my own dissections. The speci-
ed in my hands by Dr. Morton was a young male, said
out fifteen or eighteen months old, and which had lived
r. Nassau's hospitable roof for some months in quite a
manner, being very docile and affectionate in its ways.
its right arm had been broken, and that the lungs were



of head, the upper extremity 17, in the lower $13\frac{1}{2}$. The upper extremity was measured from head of humerus to tip of middle finger; the lower from head of femur to tip of middle toe.

What struck me at once as regards the extremities was the great length of the upper extremities, the tips of the fingers reaching $3\frac{1}{2}$ inches below the knee when the animal stood erect. The length of the upper extremities is conditioned by the peculiar gait of the Gorilla, which shuffles along semi-erect on all fours, using the extended hand as a fulcrum, and not flexing the fingers like the Chimpanzee. I make use of the term hand intentionally in contradistinction to that of foot, as, in my opinion, Prof. Huxley¹ has satisfactorily proved that the upper extremity is terminated by a hand and the lower by a foot. The hand, Plate V., fig. 1, measures 5 inches, and is slightly longer than the foot, Plate V., fig. 2, which is $4\frac{1}{2}$ inches long.

A very noticeable difference in this young male, as compared with an old one, is the absence from the head of the crest or ridge of bone running along the sagittal suture of the skull, which is so characteristic a feature of the skull of the adult male Gorilla. As the animal advances in life the temporal muscles develop, and their great size necessitates a firm basis of origin, and hence the absence of this bony ridge at the early age of two years. The young Gorilla, however, exhibits that width and elongation of the face and massiveness of the jaws, Plates III. and IV., which give the animal such a bestial aspect, so remarkable also in the Papuans, Hottentots, Caffres, and some others of the lower races of mankind. The part of the head containing the brain, however, is



On removing the calvarium the brain was found almost entirely decomposed. The base of the skull was remarkably human in its appearance, and the following measurements were noted: Antero-posterior diameter, from the foramen cæcum to the torcular herophili 4. inches; lateral diameter through sella turcica $3\frac{1}{4}$ inches; lateral diameter from bases of petrous portions of temporal bones $3\frac{1}{2}$ inches. The distance between the foramen cæcum and olivary process measured $1\frac{1}{2}$ inches, from olivary process to posterior clinoid process $\frac{1}{2}$ inch; sella turcica to torcular herophili $2\frac{3}{4}$ inches; outer border of lesser wing of sphenoid to ridge of temporal $1\frac{1}{2}$ inches. These measurements indicate a well-formed and relatively large brain.

The number of teeth in the Gorilla, like all the catarrhine monkeys, is the same as in man. The ferocious aspect of an old male is due to a great extent to the large size of the canine teeth, which in the young male are comparatively small. The neck in my specimen is short and thick; the chest and shoulders broad, the body long.

As the skeleton of the Gorilla has been admirably described by Prof. Richard Owen,¹ it would be superfluous for me to consider it here, and I take the opportunity also of testifying to the general accuracy of the description of its myology by the late Prof. Duvernoy, so far as my specimen enables me to make a comparison. In some parts the muscles were too much decomposed to determine positively their origin and insertion, and in some instances muscles described by Duvernoy were certainly wanting in my specimen dissected by me, or had a different disposition. As the muscles of the extremities are the most interesting, being regarded by Prof. Huxley as among the tests for the binomous or quadrumanous nature of the Gorilla and other monkeys, I will confine myself more particularly to the description of the muscles I found in the extremities of this specimen.

In reference to the muscles of the arm in my specimen the coraco brachialis, brachialis anticus, and triceps did not differ in any way from the corresponding muscles in man. But when I was present the latissimus condylodens, its name indicating its origin and insertion—a muscle which I have found in various

¹ Zoological Trans., vols. 4, 5.

² Archives du Musée, 1855-56.

other monkeys, viz., *Cynocephalus*, *Cercopithecus*, *Macaca*, *Cebus*, *Hapale*. This muscle has been described as occurring also in the Chimpanzee, Orang, and Gibbon. I have seen it as an anomaly in the colored races of men, and it has been recorded as also occurring in the white races. The only differences as regards the superficial muscles of the anterior aspect of the forearm compared with those of man are that the pronator radius teres arises by only one head, and by that from the internal condyle of the humerus, and that the palmaris longus is absent. The latter, however, is sometimes absent in man. There was no appreciable difference in the origin and insertion of the flexor carpi radialis, flexor carpi ulnaris, or flexor sublimus digitorum. Of the deep muscles of the forearm, the pronator quadratus and flexor profundus digitorum offer in this specimen nothing specially different from those of the same muscles in man. But an interesting peculiarity is the entire absence of a flexor longus pollicis. According to Duvernoy, the flexor profundus digitorum in the Gorilla gives off a tendinous slip which passes to the thumb, and corresponds to the flexor longus pollicis. Such a disposition I have seen in the various genera of monkeys I have dissected. But in this Gorilla there was no trace of a flexor longus pollicis either as a distinct muscle or as a tendinous portion of the flexor profundus digitorum. Thinking that perhaps this might be an anomaly, I looked carefully for the muscle or the tendon in the other hand

specimen of the Gorilla. As regards the hand the tendons *a* of the flexor sublimis digitorum *b*, Plate VI., fig. 1, split so as to enable the tendons *b* of the flexor profundus digitorum, Plate VI., fig. 1 *b*, to pass through to their insertion. Part of the flexor profundus *c* in the figure is concealed by the flexor sublimis *b*. The carpi- and metacarpales are well developed. The thumb presented fully developed the abductor, flexor brevis, adductor, Plate VI., fig. 1 *c*, *d*, *e*, and opponens pollicis, and the little finger, the abductor, flexor brevis and opponens minimi digiti. In the disposition and relative development of these muscles I can see no difference from those exhibited in the hand of man. Briefly, then, the muscular system of the upper extremity of the Gorilla differs from that of man in that the latissimo-condyloideus is present in the former, while the palmaris longus and flexor longus pollicis are absent, and that the pronator arises by only one head.

In the thigh I noticed the tensor vaginæ femoris, the rectus, the vasti, and crureus, the adductors and pectineus, the sartorius, biceps, gracilis, semi-membranosus, and semi-tendinosus. The first two muscles in the Gorilla are more fleshy than in man, but in other respects these muscles, as well as those just mentioned, are essentially the same in their origin and insertion as in man. On the anterior aspect of the leg may be seen the tibialis anticus, extensor longus hallucis, extensor longus digitorum. The little spring from this last muscle, unfortunately called the peroneus tertius of human anatomy, is absent in the Gorilla; I say unfortunately, because the name peroneus tertius would lead the comparative anatomist to suppose it inserted in the third toe, just as the names peroneus quartus and peroneus quintus of the rabbit and numerous monkeys imply that these muscles are inserted into the fourth and fifth toes respectively, which is the case in these animals, whereas the peroneus tertius of human anatomy arises from the basal side of the fibula, and is inserted into the metatarsal bone of the fifth toe. It seems to be peculiar to man, and is sometimes absent. The peroneus longus and peroneus brevis in the Gorilla repeat essentially the characters of those muscles in man, and there is an extensor brevis digitorum. The posterior aspect of the leg of the Gorilla exhibits the flexor longus digitorum, flexor longus hallucis, tibialis posticus, and gastrocnemius, similar to the corresponding muscles in man. The soleus, however, only arises from the fibula in the Gorilla, as I have also

noticed was the case in other monkeys. The plantaris is absent in this specimen. The plantaris is, however, well developed in the Baboons, Macacques, etc. The abductor, flexor brevis, adductor of the hallux, are as evident in the Gorilla as in man, as also the transversus pedis, abductor and flexor brevis minimi digiti. The flexor accessorius is, however, absent in the Gorilla and in the Gibbon and Orang, but sometimes present in the Chimpanzees. I have found it well developed in Macacques, Baboons, Vervets, etc. The flexor brevis digitorum, Plate VI., fig. 2, *a*, in the Gorilla is somewhat different from that in man. The part supplying the second and third toes, Plate VI., fig. 2, *a'*, only arises from the calcaneum, *a*, the tendons going to the fourth and fifth toes coming off from the tendons of the flexor longus digitorum, *d*, and flexor longus hallucis, *e*, respectively. The tendon for the fifth toe is not perforated. The flexor longus digitorum, *d*, supplies especially the deep tendons for the second and fifth toes, Plate VI., fig. 2, *i*, *c*. The flexor longus hallucis, Plate VI., fig. 2, *e*, divides into two tendons, one of which, *f*, supplies the big toe, and the other, *g*, after giving uniting fibres to the tendon of the flexor longus digitorum, passes to be inserted to the third and fourth toes, *h*, *k*. The flexor longus digitorum, *d*, supplies the superficial tendon for fourth toe, *b*, and the deep tendon for the fifth one, *c*. The flexor longus hallucis, *e*, the superficial tendon for the fifth toe, and the deep one for the fourth toe, *k*. The superficial tendon for the fifth toe is not represented in the figure, it having been unfortunately torn off before it could be drawn. There are well-developed lumbricals. On comparing

moir on the *Hyllobates*, namely, that the monkeys are four-handed, structurally. That the monkeys use their feet like hands is a matter of every-day observation. But to conclude from that fact that their feet are anatomically hands is as illogical as it would be to conclude that the *Ateles* and *Colobus* possess only rudimentary thumbs, and having, therefore, no grasping power and using their hands like feet, are four-footed, not four-handed. To be consistent, those who assume that the Gorilla and other monkeys are four-handed should hold that the tail of *Ateles* is anatomically a finger, simply because it is used like one, and its upper extremity terminates in a foot and its lower in a hand.

It is interesting to notice that in the Gorilla the great blood-vessels come off from the aorta in the same manner as in man. Thus the subclavian and left carotid arteries spring separately from the aorta, while the right carotid and right subclavian originate in a common trunk—the innominate. This disposition of the vessels is also seen in the Chimpanzee, according to Vrolik.¹ With this exception, the arrangement of these bloodvessels in all the other monkeys is that the left subclavian comes off separately from the aorta, but that the left carotid originates in the innominate, as well as the right carotid and right subclavian. I have noticed a similar arrangement, with minor differences, in several animals as the Tiger, Squirrel, Guinea-pig, Kangaroo. It should be mentioned, however, that the origin of the bloodvessels which obtains in man, the Gorilla, and Chimpanzee, is not characteristic of these animals, as I have seen a similar arrangement in the Hedge-hog, Seal, Beaver, Sloth, Wombat, and, according to Meckel,² is found in the Ornithorhynchus. In reference to the vascular system of the upper extremity of the Gorilla, there was nothing essentially different from that of man. The brachial artery divided into the radial and ulnar; the palmar arch and digital vessels exhibited the human arrangement. I noticed the cephalic and basine veins, the radial, median, and ulnar. The only peculiarity about the vessels of the lower extremity was that of the femoral artery giving off, in the middle of its course, a good sized vessel, which accompanied the long saphenous nerve and vein to the inner aspect of the foot. Possibly, this is only an

¹ Recherches sur la Chimpanzee.

² Ornithorhynchus, 1826.

anomaly, but Dr. Morton found the same vessel in the right leg. Should this vessel be found in future instances, I would call it the long saphenous artery. The distribution of the plantar arteries is the same as that in man. As regards the nerve system, the external cutaneous nerve passes through the coraco-brachialis muscle in the Gorilla as in man; the ulnar nerve, however, is imbedded in the latissimo-condyloideus muscle; the median nerve, opposite the articulation of arm and forearm, gives off a branch that anastomoses with the ulnar. I have never seen such an anastomotic branch in man: possibly it is only an anomaly. The median nerve, Plate VI., fig. 1, *f*, supplies, in the Gorilla, the thumb, index, middle, and the inner side of ring finger; the ulnar, Plate VI., fig. 1, *g*, the outer side of the ring and little finger. The back of the hand receives filaments from the radial and ulnar nerves. The whole disposition is similar to that seen in the hand of man. In a similar manner to that of man, the plantar nerves furnish the nervous supply to the foot of the Gorilla. Inasmuch as the nerves, arteries, and veins of the extremities in the Gorilla are essentially the same as in man, it confirms the statement made above, deduced from the arrangement of the bones and muscles, that the Gorilla has anatomically two hands and two feet in just the same sense that man has, and what is true for the Gorilla is true for all the monkeys. I do not mean that the hand of every monkey is alike and exactly similar to that of man, or that the foot is absolutely similar in all these animals. On the contrary, I have often noticed minor differences; but, in my opinion, to say that a monkey is quadrumanous in its structure

sent in the *Ornithorhynchus*. In that portion of the small intestine that was intact I observed the glands of Peyer, relatively large and well developed. The vermiform appendix was present, and measured two and a half inches. This interesting structure is also found in the Chimpanzee, Orang, and Gibbon, but is absent in other monkeys; it is, however, found in the Wombat. I noticed it in three animals of that species that I have dissected. The intestines contained the remains of half-undigested vegetable food.

Although the Gorilla was said to be nearly eighteen months old, the scrotum was hardly developed; the testes, however, could be felt just below the external abdominal ring, and the communication between the greater cavity of the peritoneum and that of the *testis vaginalis testis* was unclosed.

What conclusions can be drawn from this brief account of the structure of the Gorilla as to its place in Nature? In 1864 appeared the admirable "Man's Place in Nature," by Prof. Huxley, in which the general proposition is maintained that the gap between the Gorilla and the lower monkeys is greater than that between the Gorilla and man.¹ With all deference to that profound thinker, it appears to me that that proposition, while generally correct, is not strictly so, since there are present in man and the lower monkeys certain muscles, like the *flexor longus pollicis*, or its analogue, and the *flexor accessorius*, which are absent in the Gorilla, while the Gorilla and the lower monkeys possess the *triceps brachii* and *condylodens* muscle, which is absent in man, except as a rudiment. I call attention to the above essay of Prof. Huxley, not so much in a spirit of criticism, for I am in accord thoroughly with the tenor of the work, as to account for the general error so common among non-professionals, that evolutionists hold that man has descended from the Gorilla. Prof. Huxley certainly did not intend, in the famous work referred to above, to leave the reader with the impression that man had descended from a Gorilla. But as a detailed comparison was made between man and the Anthropoids, there was a widespread impression developed by the publication of that book, that such a view was held by Darwinians, and advocates of the development theory generally, for which Prof. Huxley is unjustly held responsible, as too many cite his work without having read it.

¹ *Man's Place in Nature*, pp. 84, 104.

Having had the opportunity of dissecting numerous genera of monkeys, and always while so doing reflecting on their structure as compared with that of man, I venture to state that I do not think any monkey now known can be regarded as the ancestor of man in general, and the Gorilla certainly not in particular. On the contrary, however, I believe that all the facts go to show that the different kinds of monkeys are the modified descendants of one ancestor, and that the different races of men have similarly descended from a common ancestor, and, further, that the ancestors of the monkeys and man had a common ancestry. In a word, man, the Gorilla, the Chimpanzee, and the Orang, etc., are distantly related, man and monkeys being members of the same order, Primates, and that there is no race of man, recent or fossil, or kind of monkey, now living or fossil, that will adequately represent the primitive man or the primitive monkey, and still less the common ancestor of both. If this view be correct, a "missing link" ought not to be expected to be found. While a firm believer in the doctrine of evolution, and while being entirely satisfied that the form of any animal or plant is the resultant of incidental forces upon plastic matter, and that the problems of morphology are questions of the redistribution of matter and motion, simple physical problems to be considered in the same spirit as the phenomena of electricity and chemistry are investigated, I must say that the genealogy of man has not as yet been worked out.

DESCRIPTION OF A NEW SPECIES OF DOLABELLA, FROM THE GULF OF CALIFORNIA, WITH REMARKS ON OTHER RARE OR LITTLE-KNOWN SPECIES FROM THE SAME REGION.

BY ROBERT E. C. STEARNS.

THE forms referred to herein are part of a collection made in 1876, by Mr. William J. Fisher, of San Francisco, and kindly presented to me by the collector. In connection with the previous abundant material in my cabinet from Lower California and the shores and waters of the Gulf of California, Mr. Fisher's contribution adds much to our knowledge of the forms inhabiting the above province, their distribution and variation. I propose to publish additional papers in continuation of this, with notes and comments relating to these points.

***Dolabella Californica*, Stearns. (New Species)**

This form appears to have escaped detection until collected by Mr. Fisher, who found it living in Mulege Bay, Gulf of California; it prefers "dark places in pools left by the tide."

Though several specimens of the animal were procured, I was unable to obtain a specimen for investigation. Mr. Fisher, who made no drawings at the time of collecting, informs me that the animal is of the same general form as authors have given for *D. gillii*: the color of the above species being a dark-brown, and the surface covered with warty papillae. As to color, this species probably varies somewhat as do the individuals of others.

The species heretofore made known are principally inhabitants of the Indo-Pacific province, and the Mediterranean region is also credited with a representation of this group.

The figures, Plate VII, 1 and 2, of natural size, which I have carefully drawn from the largest of the two shells in my collections, resemble in outline, somewhat, the shells of *D. Rumphii* of Cuvier,

D. scapula, Martyn. The nuclear callosities vary more or less in different specimens.

Marx *Ocenebra orinaceoides*, Val. (=*O. Californicus* Hds.)

In the late Dr. Carpenter's Reports to the British Association, reference is made to the foregoing species (*Muricea orinaceoides*) by name only. In his Mazatlan Catalogue, however, he

¹ See Woodward's Manual, 2d ed., p. 321.

has described a "var. indentata," of a form which he presumes to be Valenciennes, species, and suggests a comparison with Kiener's *Murex alveatus*. In the Smithsonian Check List (June, 1869), he included Kiener's name, but omitted that of Valenciennes. As neither Kiener's nor Reeve's monographs are accessible, I have only been able to compare with Chenu's figure 583, as presented in the latter's Manual, Vol. I., p. 137, which is quite a different form from that herein considered, and which I have no doubt is the shell described by Valenciennes, for his name is so eminently appropriate, that if there is any question or confusion of names, his should be retained. The shell referred to has frequently come under my notice, and its determination has sorely puzzled others as well as myself. The specimen before me at this moment, which is only about half the size of some in my collection, is exceedingly suggestive of the European *erinaceus*, and the characters and range of variation in the two species are very much alike, though large adults vary more than do the smaller individuals. The West American form, when adult, is more triangular, and exhibits a general variation in the direction of *Pteronotus*.

The genera *Muricidea* and *Ocinebra*, as defined in Adams's Genera, when considered in the light of some of the species included by said authors in each of the two groups, will be found on comparison to approximate so closely as to create a doubt as to, in which of them, certain forms should be placed. I am

302. 1833), indicates that Mr. Stearns' identification of this species is correct. It has been since described by Mr. Hinds in Zool. Proc. London, 128, 1843, under the name of *Murex Californicus* Hinds; and excellent colored figures are given in Voy. Sulphur., t. 3, f. 9, 10. It is also figured in Reeve, Conch. Icon. sp. 144, under the latter name. Hinds describes the shell as having six varices, but his figures only show three; Reeve's description is correct in mentioning three varices alternating with nodes or ribs. The specimen sent by Mr. Stearns, with his paper, has but three varices. I think that Mr. Hinds has erred in including the three internodes as varices in his description. The species cannot be placed in either *Octubrera* or *Muriceida*. Until the operculum shall be examined, it will be impossible to group it with certainty; if the operculum is muricoid, it is a *Chicoreus*, Montf.; if purpuroid, it is a *Cerastoma*, Conr. Geographical considerations lead me to surmise that it will prove to be the latter. Broderip (Zool. Proc. 175, 1832) described *Murex lugubris*, a species having five or six varices, and much resembling *M. erinaceus*. It occurs from Puerto Portrero, Central America, to Magdalena Bay, and is figured by Sowerby, Conch. Illust. f. 26, and by Reeve, Iconica, p. 144. If this should prove to be the same as Valenciennes's species, the name would take precedence, having a year's priority.

(G. W. T., Jr.)

Macron Ethiops, Reeve — *M. Kellatti*, Hinds.

Numerous fine specimens were found alive on mud flats in San Quentin bay, which indisputably connect the foregoing.

Reeve's species was probably described from a large specimen, in which the entire surface of the whorls was broadly and more or less deeply channeled or grooved, as in specimens in my collection, which measure 2.9 inches in length by 1.92 inch in width; from this, younger specimens, as small as 1 inch in length by .58 inch in width (the outer lip thin at this age), show the same characters.

In *Kellatti*, the type, as figured in Chenu's Manuel, measures 1.86 inch in length by 1.10 inch in width, and exhibits only three of these channels near the base of the body whorl. Mr. Fisher's specimens prove that the grooving is an uncertain character. The number of individuals collected by him was fortunately ample enough to settle all doubts, and prove that the two forms as

above should be united under one specific name; as Mr. Bond appears to be the first in order of time, it must be adopted.

All of these shells, when alive or fresh, are covered with a thin or nearly black epidermis, which is apt to flake or peel off when very dry. (The epidermis has the same characters in the *Mitra Belcheri*, in common with other West American related forms, and we may presume lives in mud stations.)

The varieties of *Macron* may be described as follow:—

I. Length 2.02, breadth 1.28 inches; channelled throughout more conspicuously on lower part of body whorl than elsewhere. Plate VII., fig. 3.

II. Length 1, breadth .57 inch; outer lip immature; channelled throughout.

III. Length 1.76, breadth 1.10 inch; channels obsolete or very so on upper part of body whorl. Plate VII., fig. 4.

IV. Length 1.22, breadth .82 inch; channels strongly marked below, fainter above and on the greater part of body whorl; on upper part of same barely perceptible.

V. Length 1.58, breadth 1 inch; three grooves on lower part of body whorls; otherwise smooth; typical of Hinds' form. Plate VII., fig. 5.

Although the other West American species, described by Adams, and named *M. lividus*, Plate VII., 6, habitat San Diego on the ocean coast in the State of California, is a smaller form

***Cyprina (Laponia) controversa*, Gray.**

In Sowerby's monograph of *Cyprina*, in his *Conch. Illustr.*, species 30, figure 136, no habitat given, reference is made to what I have always regarded as applying to the form under consideration. The only comment in the text as above is: "30—*C. controversa*, Gray, Zool. Journ., t. 7 and 12, p. 7. *Obs.* This may prove to be only a variety of *C. Isabella*."

While its general coloration would lead to its being grouped with *C. isabella* of the Indo-Pacific and *C. lurida* of the Mediterranean regions, it differs more from the former than it does from the latter named species. While it is a more ventricose form than *C. isabella*, in this respect being nearer to *C. lurida*, the edges of the lips are not as finely and closely crenulated as in *isabella*, nor as coarsely as in *lurida*.

As the specimens which first attracted the attention of Californian collectors and naturalists were beach shells, they were regarded as ballast specimens of *isabella* from some Indo-Pacific port, thrown over from some ship, or accidentally mixed in with gulf shells by sailors, and were not carefully examined or considered. Their frequent reception from the gulf has led me to look into the matter, with the result as above stated.

Mr. Fisher collected several fresh living specimens at the Maria Madre, and at San Juanico Islands of the Tres Marias group, and the species should be added to the faunal list of the Mazatlan province.

***Onchidella Carpenteri*, Stearns. *Onchidium Carpenteri*, W. G. Binney**

The form referred to herein, which I presume to be the same imperfectly described from alcoholic specimens by Mr. Binney in the Proceedings of the Philadelphia Academy of Natural Sciences, 1860, page 154, is an *Onchidella*, as said genus is defined by Woodward,¹ the generic description and type (*O. Typha*, Buchanan) being considered, together with numerous specimens collected by Mr. Fisher at various places in the gulf of California.

Although Mr. Fisher's specimens are somewhat contracted and distorted by alcohol, they are probably in better condition than were those examined by Mr. Binney, and I am therefore able to add the following to that author's descriptive remarks:—

Body oblong ovate, about one-third longer than wide; convex

¹ Recent and Fossil Shells, 2d ed., 299.

or rounded above, flat on the under side; anterior and posterior ends equally rounded. Dorsum formed by the mantle, and entirely covering the back, which is of a smoky brown color, coriaceous and quite thick at the edges, as seen from the under side, which latter is of a dingy yellowish color. Surface of dorsum closely covered with rough wart-like papillæ, some larger than others; the largest placed so as to present somewhat the aspect of regularity, the interspaces being filled with the smaller. Creeping disk or belly elongated, nearly as long as the animal, and its width about one-third of the entire width, as seen from below.

Respiratory orifice on the left side, between the edge of the creeping disk and the mantle, at a point about two-fifths of the total length, from the posterior end. Anal outlet on the right side, very near the posterior extremity of, and just above the edge of, the creeping disk.

The eye peduncles rather short, and these, together with the buccal appendages, are obscured through the contraction caused by the alcohol.

The creeping disk, being comparatively soft, is much contracted by the same cause.

[Abundant, attached to the under side of stones, at low tide. Sometimes overlapping each other.—W. J. Fisher.]

Habitat. Gulf of California, in San Francisquita Bay, Los Animas Bay, and Angeles Bay.

The above was written, and Plate VII., figure 7, drawn (twice the actual size) from an alcoholic specimen in my collection. It



, etc.). The type of this last genus *T. longana*, Quoy, is conspicuously different to admit of this; the balance of arguments being decidedly in favor of the group first named and to which I regard it as more nearly related.

Dorsal eyes, detected by Prof. Semper in certain forms of *T. æ*, and which he has so carefully illustrated and described, I have not been able as yet to discover in any of the specimens examined by Mr. Fisher.

**ON A BELT OF SERPENTINE AND STEATITE IN RADNOR TOWNSHIP,
DELAWARE COUNTY, PA.**

BY THEO. D. RAND.

There is a well-known belt of serpentine passing through Radnor Township, in a direction about N. 80° E. from near Radnor Station, P. R. R., continuing probably to West Chester, S. 75° W., and which is probably identical with that apparent at the Schuylkill at Rose's quarry, nearly opposite Lafayette Station, P. G. & N. R. R.

This serpentine is very dark, and is almost without other minerals except asbestos. Northwest of this is another belt, which I believe has never before been described.

Its southeasternmost outcrop is on the S. W. side of the gulf road, about 150 yards S. E. of the road from Radnor Station to Coughoocken, and in, but near the southeastern border of, the Edge Hill hydro-mica schists, which a quarter of a mile N. W. form the Gulf Hills, the continuation of which is known as the South (Chester) Valley Hill. Its outcrop is a very small one, not over six or eight feet in width, and has been exposed by a cutting of the road.

The serpentine is of a reddish- and also of a blackish-green color, quite compact. No other minerals are visible.

About a mile, S. 73° W., from this point, a similar serpentine appears, ploughed up in a field on the property of the heirs of Mark Brooke. This point is about five-eighths of a mile nearly N.

road from Radnor Station to Conshohocken, N. E. of the road separating Delaware from Montgomery County. The steatite, with two distinct parallel outcrops, with primal sandstone between, appears near the same road in a ploughed field, but only as loose masses, on a farm formerly owned by Christopher Pechin; no serpentine was found.

These two exposures of the steatite are about half a mile apart, and the direction is nearly N. 70° E.

The serpentine on the gulf road is very nearly in the same direction, and although no steatite was found on the gulf road, except one small piece, I was assured by Mr. Garrett Williamson, who has resided in the neighborhood for years, and who first called my attention to the fact that steatite existed in the vicinity, that steatite had been found in place in digging the gutters of the road, about one hundred yards southeast of the serpentine, and on searching at this point the small specimen mentioned was found.

The continuation of the line was followed, but no other exposure was seen. The strike is nearly the same as that of the Edge Hill rocks, the trap, the primal slates, and the Gulf Valley; varying about 18° from that of the steatite of the soapstone quarry, from Chestnut Hill to the black rocks near Merion Square, and its probable continuation from Rosemont southwestwardly.

The question at once suggests itself: Is this steatite of the soapstone belt on the northeasterly side of an anticlinal axis? The presence of the garnetiferous mica schist favors this view, but the occurrence on the gulf road on the Edge Hill rocks, and the presence on the northeast of the primal slates are opposed to it. I desire at present merely to put the facts upon record, hoping that future discoveries may render them of value towards development of the geology of the region.

The line of strike of this belt would be just at the brow of the hill on the southwest side of the Schuylkill, overlooking Conshohocken. Granitoid gneissic rocks are there in abundant outcrops, but no serpentine or steatite has been noticed.

I desire also to call attention to a fact which probably indicates a line of fault in the upper part of the valley of Mill Creek. The soapstone belt of the soapstone quarries is found in a very nearly perfect line, about S. 54° W. from Chestnut Hill, Philadelphia, to near Merion Square, Montgomery County, where it is very

prominent in the so-called black rocks. It continues, however, in the same direction at least half a mile further, being exposed in the Black Rock Road at the curve in that road N. E. of Mr. Chas. Wheeler's, beyond which it does not appear. The prolongation of this bearing would strike the Penna. R. R. at or near the bridge by which the Black Rock Road crosses it. The road cutting is here some thirty feet deep for over half a mile in decomposed mica schist, without a trace of staurolite, but at Rosemont, a distance, measured at right angles to the strike, of about half a mile, and in direction due west, it again appears northeast of the railroad. Near Darby Creek, about two and half miles S. 55° W. are other outcrops, the course being S. 55° W., beyond which it widens into a broad belt of serpentine and allied rocks to the West Chester road, identified by the pseudomorphs of serpentine after staurolite, the so-called bastard serpentine.

Blue Hill, Providence Township, is nearly in the prolongation of this line, as also Walter Green's in Marple.

The serpentine belt first mentioned has a similar change of direction; from Rose's quarry to a point on the Barr farm, 1.5 miles north from Bryn Mawr, its direction is about N. 65° E. prolongation striking the Pennsylvania Railroad at a point a mile above Rosemont, whereas, at its first outcrop near Red Bank Station, it is about half a mile north of this assumed line, and thereon pursues a course about S. 75° or 80° W. The outcrop

DECEMBER 3.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-four persons present.

On Tania mediocanellata.—Prof. LEIDY exhibited two specimens of tapeworms, *Tania mediocanellata*, both retaining the head. These had been recently submitted to him for examination by Dr. James J. Levick and Dr. Walter F. Atlee. Tapeworm appears not to be a common affection with us. Several physicians, in extensive practice in this city, had informed him that they never had a case. During the last ten or fifteen years, from one to two specimens annually had been submitted to him, but the present year he had seen five specimens. He had been surprised to find that all pertained to the species indicated. Formerly he supposed that our common species was the *Tania solium*, but later experience would indicate that the *Tania mediocanellata* is the more common. The distinction between the two had been observed only comparatively recently, so that no doubt many specimens formerly attributed to the former actually belonged to the latter.

When the head is present, the two species are readily distinguished. The *Tania solium*, whose larval form is found in the "measle" of pork, has the head provided with a crown of hooks. *Tania mediocanellata*, derived from beef and mutton, has a larger head, which is unarmed. The ripe segments are also usually readily distinguished in the two species. In the *T. mediocanellata*, the ovaries are divided into many more pouches than in *T. solium*.

In Dr. Levick's case, the man had been in the habit of eating roasted meat. In one of the specimens exhibited, the suckers of the head appeared as black spots, from the black pigment on the anterior surface. The genital apertures were also black from the same cause. In the other specimen, the head appeared less black from pigment about and around the position of the suckers, and the genital apertures do not appear black.

Mountain Soap of California.—Prof. GEORGE A. KOENIG stated that the so-called mountain soap has a uniform, impure white color, and is gritty to the touch. Examination with the lens does not reveal the composite nature of the substance, but when crushed (not ground), and stirred with water, it assumes a pasty consistency like Kalamite, and by continued stirring with much water passes into a milky suspension. From this in a short time a sandy material deposits, while the remainder requires many hours to settle and the water into a flocculent mass. Thus two portions were obtained, a sandy one, A (45 per cent.), and a flocculent one, B (55 per cent.), roughly. Both were dried over sulphuric acid.

Analysis of B:—

Ignition	6.70 per cent.	
Decomposed by H_2SO_4	28.00 per cent.	
		$Al_2O_3 = 12.00$
		$SiO_2 = 15.40$
		(Amorphous SiO_2)
Dissolved by KHO	88.80 per cent.	
Insoluble residue	24.35 per cent.	
		$SiO_2 = 22.4$
		$Al_2O_3 = 1.30$
Not determined	9.075	
$CaOK_2O, Na_2O,$	100.00	

B is, therefore, a mixture of Kaolinite, opal silica, feldspar mineral, and quartz.

Examination of Part A:—

Ignition	12.24
SiO_2	69.40
Al_2O_3	13.50
CaO	0.60
MgO	0.80
Alkalies (difference)	4.00
	100.00

But this also parts into a soluble and an insoluble portion.

Insoluble	38.50 per cent.	$SiO_2 = 32.00$
		$Al_2O_3 = 6.40$
Soluble	61.50 per cent.	$SiO_2 = 42.2$
		$Al_2O_3 = 6.8$

It is absolutely impossible to identify any species with certain under these circumstances.

Tuckerman found it in the White Mountains of New Hampshire; Rush credited it to the Green Mountains of Vermont, and it has long been known to occur in that State at Mt. Willoughby, and in Smuggler's Notch at the base of Mt. Mansfield; Frost found it also near Brattleboro, Vermont; Macrae, many years ago, collected it in the Adirondack Mountains, Essex Co., N. Y. In 1869, Mr. Redfield found it at Stony Clove, in the Catskill Mountains, N. Y., and in 1873, Mr. S. H. Hall collected it at Haines Falls, in the Kaaterskill Clove of the same mountains, these being our most southern localities until now, when we find it in northeastern Pennsylvania, about latitude $41^{\circ} 20'$, and at an elevation of about 2000 feet above tide.

DECEMBER 17.

The President, Dr. RUSCHENBERGER, in the chair.

Forty-one members present.

A paper, entitled "Morphology of the Limbs of *Amphiuma*, and the probable Synonymy of the Species," by John A. Ryder, was presented for publication.

The deaths of Eli Geddings, M.D., a correspondent, and Samuel J. Reeves, a member, were announced.

The Publication Committee reported in favor of the publication of the following papers in the Journal of the Academy:—

"Descriptions of new species of fossils from the Pliocene Clay Beds between Limon and Moen, Costa Rica, together with notes on previously known species from there, and elsewhere in the Caribbean Area." By Wm. M. Gabb.

"Descriptions of Caribbean Miocene Fossils" By Wm. M. Gabb.

DECEMBER 24.

The President, Dr. RUSCHENBERGER, in the chair.

Fifteen persons present.

A paper, entitled, "On the Land Shells of the Mexican Island of Guadalupe, collected by Dr. E. Palmer," by Wm. G. Binney, was presented for publication.

DECEMBER 31.

The President, Dr. RUSCHENBERGER, in the chair.

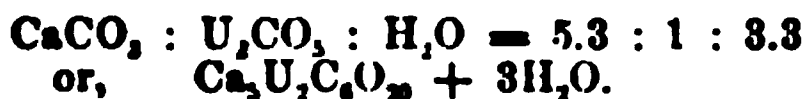
Thirty-seven persons present.

Mineralogical Notes: Randite.—Professor GEORGE AUG. KÆNIG laid before the Academy some specimens of granite from the neighborhood of Philadelphia, showing an incrustation or coating of a canary or lemon-colored substance, which he had analyzed. This substance is probably crystalline, with generally an earthy habitus. It is translucent, with a fine yellow color, and a hardness from 2-3. Owing to the impossibility of complete separation from the underlying orthoclase, the specific gravity was not determined.

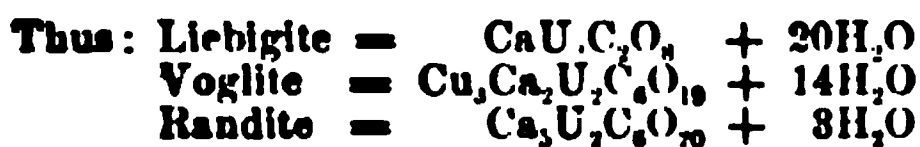
Heated in a closed tube, the mineral yields a small quantity of water (not acid), and turns to orange-red. Heated in the forceps in a strong oxidizing flame, it becomes shining black. It dissolves in a bead of microcosmic salt with effervescence (CO_2), imparting to the glass the characteristic yellowish-green color of uranium, changing to bluish-emerald green in the reducing flame. Concentrated cold hydrochloric acid dissolves it before ignition; after ignition only hot acid dissolves it completely. On no other part of the rock would hydrochloric acid produce effervescence, except where the yellow crust was visible. It is reasonably but not absolutely certain, therefore, that the substance examined was not a mixture of calcite with the yellow material. The quantitative analysis was made with 47 mgrs. of material, as follows: The substance was put into a platinum boat, and brought to beginning red heat in a tube of hard glass, 6 inches long, $\frac{3}{8}$ bore, the tube

Percentage composition,

CaO = 32.50	requires	CO ₂ = 25.49
U ₂ O ₃ = 31.63	"	" = 4.83
H ₂ O = 6.53		
CO ₂ = 39.84 (difference)		CO ₂ = 30.32 (calculated).
100.00		



Qualitatively this mineral is identical with *Liebigite*, but the ratio and the percentage of water is very different. *Liebigite* has a fine green color. *Voglite* is green likewise, contains copper, and has twice the quantity of water.



The name is proposed in honor of Mr. Theo. D. Rand, of Philadelphia, who mentioned some qualitative tests with this mineral to the author some two years since. The specimens were obtained from Dr. A. E. Foote. It is self-evident that further examination, with a more liberal supply of material, is needed to establish this mineral thoroughly as a new species.

The following reports were read and referred to the Publication Committee:—

**REPORT OF THE PRESIDENT FOR THE YEAR
ENDING NOVEMBER 30, 1878.**

The progress of the Academy during the year has been satisfactory. The means to facilitate investigations in the several departments of natural science have at no time been greater since the foundation of the Society. Valuable additions to the library have been made by exchange of the Academy's publications for those of kindred societies at home and abroad, by the generosity of authors and editors, and largely by the I. V. Williamson Library Fund. Most of the collections of natural objects have been considerably augmented.

Materials awaiting investigation and study are abundant, and the records of information relative to every department of natural history are not more numerous in any library in the country. All these materials and means of study are accessible to those interested in the pursuit of knowledge of natural objects. It is no fault of the Academy's organization or policy that the number disposed to avail themselves of these advantages is not greater than it is. All are invited, and all who accept the invitation to work in the building are cordially welcomed, and the resources of the museum and library are opened to them.

Thanks to the generosity and public spirit of Mr. I. V. Williamson and the late Dr. Thomas B. Wilson, a library fund has been established which is sufficient to procure almost all new and current publications; though not enough to supply every standard work which naturalists may desire to consult. It may be said, however, that it assures a continuous increase of the library at a rate of about five hundred volumes a year.

An adequate publication fund is very much needed. Including the bequests of Mrs. Elizabeth P. Stott, Augustus E. Jessup, and Isaac Barton, the total income applicable to publication is about \$700.

It is believed that the prosperity of the Academy depends largely on its publications, and without them it would be unknown and virtually cease to exist in a scientific sense. They constitute a bond of relationship with societies engaged in like pursuits in all parts of the world and make the Academy known to them and them to the Academy. Indeed the Journal and Proceedings are the vocal organs of the Society through the functions of which it holds communication with the naturalists in all civilized countries. Consisting chiefly of records of discoveries in natural science made by members of the Society, they contribute to the history of scientific progress. The respectability of the Academy is measurably dependent on the importance of the discoveries announced in these publications; and their quality is the criterion of the Academy's scientific character at home and abroad. Their value and importance cannot be precisely reckoned in money's worth. They encourage students to labor, for it may be safely conjectured that few would engage in original investigations without assurance of a way to make known their discoveries to the scientific world.

Besides, they bring to the library very essential and important additions. During the past year the Academy has received in exchange periodicals and serials from 45 editors and from 240 societies, or 285 publications, which, if the Academy ceased to publish, could not be procured for less than about \$1400.

The Publication Committee carefully scrutinizes all expenditures, and spares no pains to secure economy in the execution of the work assigned to it. Important communications are sometimes rejected solely for want of means to publish them. Some authors contribute the plates necessary to illustrate their de-

scriptions rather than their work should not appear under authority of the Academy's imprint; but there are many students whose financial condition will not permit them to give more than the results of their own labor.

The manufacture of the Journal of the Academy and of the Proceedings of the Academy costs, on an average of the past three years, \$1740 a year. This sum includes the expense of paper, printing, plates, and binding. The authors of the papers published receive no pecuniary compensation for their labors. The difference between the sum (\$700) applicable to publishing and the actual cost, is derived from the fees of a small number of subscribers and the general income of the Academy, and in amount is equal to one-fourth of the annual revenues, exclusive of trust and special funds.

Besides the "Journal" and "Proceedings" publications of another kind should be made from time to time for the benefit of those students who reside at distant points, as well as of those who live in the city. It is not entirely satisfactory to possess manuscript catalogues of the library and of the collections. It is desirable to have a descriptive or indicative list of specimens in each class of the several collections in the museum, so arranged that a naturalist might be at once informed by reference to it whether the object he wishes to inspect is in the Academy, before seeking it in the museum. Such lists carefully prepared and printed, to be furnished on application on such terms as may be considered proper, would make known what is in the museum as

be sufficient to defray the current expenses for salaries, warming, lighting, freight, postage, stationery, etc., even after the completion of the edifice.

Attention is respectfully invited to the necessity of establishing a curators' or museum fund of five or six hundred dollars a year, to be expended for mounting, properly displaying, and preserving objects in the various collections, and procuring whatever may be necessary to their completeness.

Fees of initiation and life-membership might be appropriated to this purpose. In the course of a few years the amount necessary to create the fund required would be accumulated, and then those same resources could be made available for some other necessity.

Deficiencies and defects now noticeable in the museum are in a great degree fairly ascribable to the want of a curators' fund. A brief reference to its present aspect may possibly make this apparent.

The museum is the aggregate of gifts received in the course of the past sixty-six years from very many generous persons, some giving one or more specimens and some entire special collections. Those departments having numerous and enthusiastic votaries have grown greatly, while those which have attracted comparatively few students are very slenderly furnished. This inequality of representation of the several classes of objects is inevitable in this museum, which originated in and is entirely dependent upon individual bounty for its formation; and, until within the past three years, upon unpaid labor exclusively for its arrangement, and the suitably mounting and display of specimens. Yet, in spite of a want of sufficient means for the purpose, the thousands of valuable and rare objects collected here are carefully protected against the ordinary causes of deterioration and loss. Fragile and perishable specimens, which were presented more than sixty years ago, are still quite perfect. The richness of some of the collections in unique and type specimens, placed here from time to time since the early days of the institution, is well known. In this connection no complaint can be reasonably made. No pains have been spared to secure the preservation of specimens placed in charge of the curators, and no loss can be fairly ascribed to their want of attention or care.

Had there been power at the outset to form a museum on a

carefully matured plan to be realized under competent direction, all its departments, we may reasonably conjecture, would have been provided for alike. Or, had there been at the commencement of the formation of this museum by individual contributors, each according to his taste or opportunity, a curators' fund applicable to the purchase of specimens required in the representation of a class or order, there would be no inequality in the several departments noticeable at this time. And it seems not extravagant to suppose that the creation of a curators' fund at this time would furnish the means to supply all deficiencies in the course of a few years.

A museum, according to the significance of the term, is a place of instruction. To render it effective to this end all the collections in it are required to be arranged according to the accepted systems of classification, and all the specimens illustrative of the class, order, or family to which they belong, to be appropriately located as far as practicable in an unbroken, continuous series, so that their relations may be readily observed.

This is illustrated in the cabinet of minerals, which has been arranged in accordance with an accepted system of classification based on composition. A student, by the aid of Dana's *Manual of Mineralogy*, may follow the arrangement from beginning to the end.

And with the assistance of Gray's *Manual*, a student may learn the accepted system of classification of plants in the botanical collections of the Academy, which are now so far arranged as to be available for study, thanks to the spontaneous labors of botani-

It will be admitted by all that the museum is excessively crowded. At least one-third of the cases on the Wilson gallery might be taken away, and then at least one-half of the birds could be removed from the remaining cases advantageously to the appearance of the museum, as well to those taking first lessons in ornithology. At present this vast collection of birds is rather stowed than displayed in the cases.

One-tenth of the number of mounted birds judiciously selected and artistically arranged to occupy all the cases in which the twenty-six thousand specimens are now stowed—almost like things in a ship—would seem to general observers a more attractive and complete collection than it is at present. Ornithologists, however, for whose benefit the late Dr. Thomas B. Wilson devoted so much care and money to enlarge the Academy's collection of birds, regard the numerous representatives of each species in it to be a prominent feature of its value which distinguishes it among the most complete in the world. Good faith and respectful remembrance of Dr. Wilson's bounty require that the Academy should preserve it and endeavor to provide more space for its accommodation rather than withdraw specimens from the collection until it suitably fits the room given to it now.

Classification of objects and arrangement of them change under the influence of experience and scientific progress; and architectural construction and limited space may compel separation of affiliated collections and the location of parts of them in the museum out of their appropriate place in the accepted system of classification. Such displacements may be admitted to be blemishes in the arrangement of a museum without admitting that they are not excusable for reasons just stated. Such unavoidable defects of arrangement do not lessen the usefulness of the museum to students.

The continuous increase of the collections indicates that the building should be completed as soon as practicable. An application made to the Legislature of the State for aid in this connection failed. The committee of the Academy charged with the subject reported substantially, January 22, 1878, that it was advisable to press the matter further at that time and was discharged.

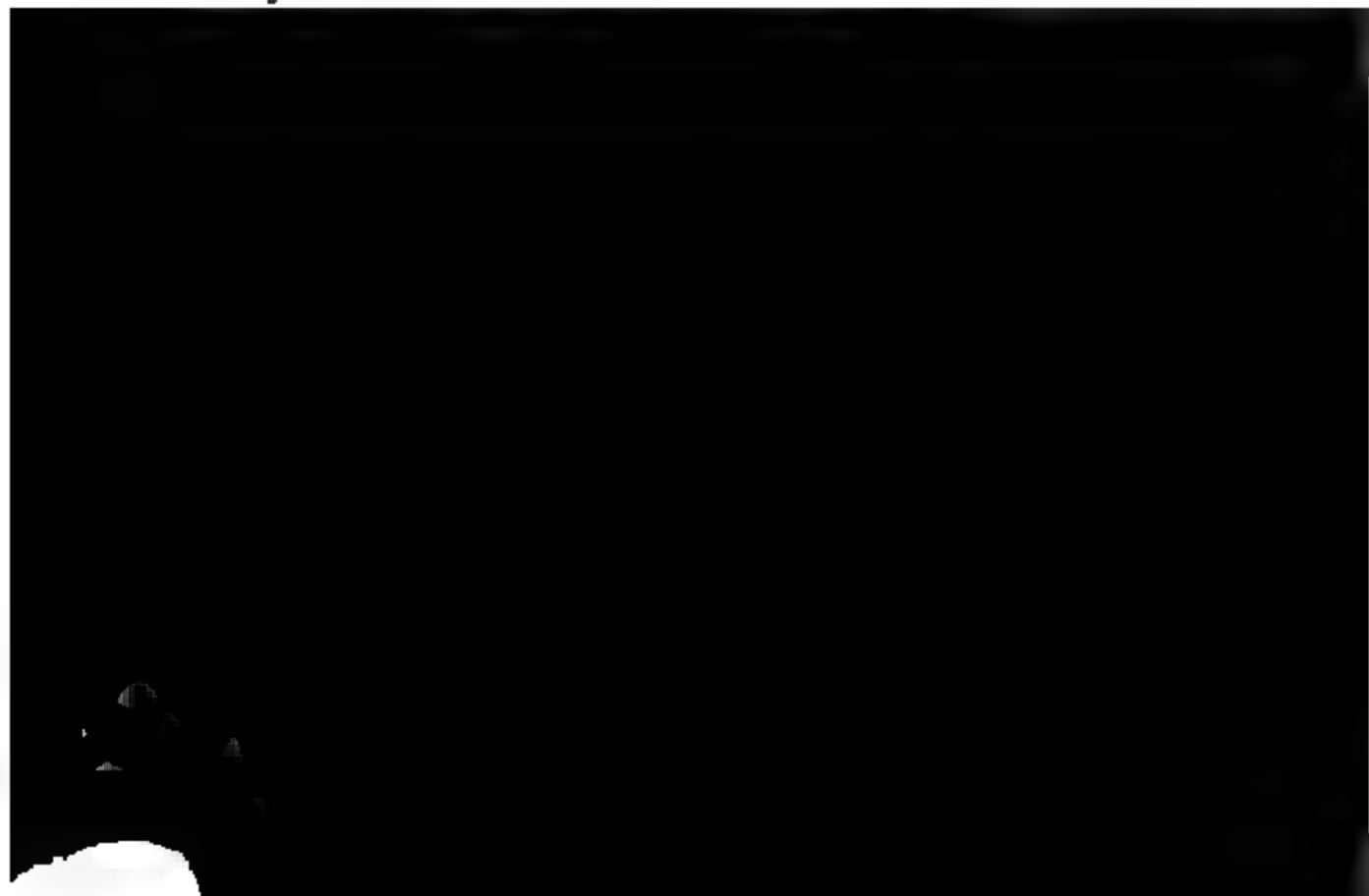
During the past year valuable additions to the collections have been made. Specimens pertinent to ethnics have become so numer-

ous that they fill a room on the entresol floor in the southeast end of the building, as well as a series of flat cases placed around the middle room at the east end of the first floor. These collections, which are very valuable, prove that interest in ethnology has greatly increased among the members of the Society during the past few years. In popular estimation no department of natural science is more important or more attractive. It is certainly worthy of the fostering care of the Academy in the future.

An arrangement of the conchological cabinet in such manner that fossil species shall be appropriately intercalated in it, want of space in the museum renders impracticable at present, although the propriety of such an arrangement is daily becoming more apparent to proficients in conchological studies.

It is conjectured that large and highly interesting collections would come to the Academy if it could afford sufficient space for their proper display and study. Proprietors are rarely willing to give valuable collections or specimens to any institution known to lack capacity to exhibit them in a suitable manner.

Considerable collections and valuable specimens contributed to the Academy by exhibitors at the International Exhibition of 1876, and confided to the care of the Smithsonian Institution for delivery, will come to us after the contemplated building for the National Museum at Washington has been completed. At present they are mingled with gifts to that institution from the same source, and will remain packed as they were for transportation hence to Washington until a suitable place for their display has been provided.



great general collection and a large and appropriate library, their value is enhanced.

Earnest desire to realize, without loss of time, plans devised for benevolent purposes, may lead to the adoption of measures which experience will prove to have been unwise.

Assuming it to have been admitted that the building should be finished, a question for the Academy to decide is whether it is prudent to accept the inconveniences and losses incident to delay, and rely exclusively on the benefactions of intelligent and generous citizens to complete the work which they have so admirably begun, rather than seek an appropriation from the State treasury, which may be obtained, if at all, under conditions that may prove to be embarrassing or unsatisfactory hereafter.

Similar institutions are largely assisted from the public treasuries of the States in which they are. The Congress of the United States appropriates annually \$20,000 to support the National Museum at Washington under the direction of the Smithsonian Institution. The Legislature of New York annually votes as much to support the State Museum at Albany, and it has appropriated nearly three-quarters of a million of dollars towards erecting a suitable building in the city of New York for the American Museum; and the Legislature of Massachusetts has voted more than a quarter of a million to aid the Museum of Comparative Zoology of Cambridge.

With such precedents in view, and considering that the Academy is eminently charitable in all its uses and purposes and educational in its character, and that all the work of its members is gratuitous, the worthiness of the Society to liberal and substantial aid from the State is scarcely to be doubted.

At this time the building fund consists of only \$2344. More than a hundred times this sum is probably needed.

The prospect of completing the building through the bounty of individuals within a reasonable time is not now encouraging, but may not be absolutely hopeless.

It is unfortunately true that the stagnation of business generally during the past three or four years has reduced incomes, and the masses are not propitious to obtain such large contributions as were so generously bestowed in the early days of this enterprise, but it is probably true that the proportion of well-to-do and opulent persons of liberal disposition is unchanged. Some may be found willing to give substantial aid to the work; and, as the cost of fire-

proof construction is less now than it was when the corner-stone of this building was laid, the aggregate sum necessary to be raised will be proportionately less.

The obstacle in the way of this enterprise is not in want of ability in the community to accomplish it in spite of its great cost, but in the indifference of the public generally to the progress of scientific pursuits among us. It is probable that the existence of the Academy is unknown to thousands of our citizens; and of those who are aware of its existence thousands have never been inside of its doors, although it is among the institutions in the prosperity of which intelligent Philadelphians are supposed to be interested.

The value of knowledge of natural objects, and of the laws which control their structure and relations, is duly appreciated chiefly by naturalists and students of nature; those of the population who are engaged in the numerous avocations affiliated more or less closely with commerce, the useful arts, including architecture and manufactures of all kinds, are generally heedless of this kind of information. They are mostly allured to the imitative and decorative arts, painting, sculpture, music, the drama, of various grades of quality. To persons of these classes, who constitute the great majority of the population, and include most of the opulent people of the city, natural science is unattractive. They regard the pursuits of naturalists to be merely the harmless, dull, uninteresting amusements of stupid people; and some look upon their labors as dangerous to religious belief: an erroneous notion, which reminds us of the famous trial which took place

may be very soon supplied, but under a belief that it is proper that members should be informed of their nature, in order that they may be considered, and such measures as in their judgment may seem expedient be adopted.

The annual reports of the curators, of the treasurer, of the secretaries, librarian, and several sections, show the progress of the Society during the year.

Professor J. Gibbons Hunt is delivering a course of very interesting and instructive lectures before the Biological and Microscopical Section, on the use of the microscope in the study of cryptogamic botany. They are heard with great pleasure. The course was commenced in October, and will be continued until April or May next.

The number of persons who consult the library, it is believed, has increased very much.

The average attendance at the stated meetings of the Academy is 32; but only about 4500 persons have visited the museum through the year. This fact suggests that in this city's population of 500,000, the taste for natural history is not very general, and that the uninstructed man here, as well as everywhere, is more interested in viewing specimens of his own genus and representation of their exploits by artists and poets than in samples of any other part of the creation. A museum which contains representatives of almost every kind of bird and shell in the whole world, besides extensive collections in all departments of natural history, it is supposed, should be attractive to great numbers of people; but experience shows that only those who are intellectually curious find the pleasure of visiting it worth the ten cent fee of admission.

Let us not be discouraged by this experience. The importance of special knowledge is slowly recognized. The proportion of educated and cultivated people in the city's population is very much greater now than it was a century ago, and among them the value of all the natural sciences is more widely and justly appreciated. It is more generally believed that seeking to know precisely what is knowable in any and every direction is of interest and value to the community, and that such pursuits are worthy of substantial encouragement.

The whole is respectfully submitted,

W. S. W. RUSCHENBERGER,

President.

REPORT OF THE RECORDING SECRETARY.

The Recording Secretary respectfully reports that during the year ending Nov. 30, 1878, twenty-eight members and thirty-two correspondents have been elected.

The following members have resigned: S. L. Shober, A. E. Hall, G. Schwartz, and R. M. Girvin.

The deaths of sixteen members, and eleven correspondents, whose names have been published in the current proceedings, have been announced.

Thirty-two papers have been presented for publication as follows: E. Goldsmith 3, Jacob Ennis 2, E. T. Cresson 2, J. A. Ryder 1, Dra. Elliot Coues and H. C. Yarrow 2, Rev. H. C. McCook 2, Wm. M. Gabb 2, C. A. White 1, Geo. A. Koenig 1, Wm. C. Stearns, Jr. 1, J. S. Kingsley 1, B. W. Barton 1, J. H. McQuillen, 1, Charles Wachsmuth and Frank Springer 1, Alpheus Hyatt 1, Wm. G. Mazyck and A. W. Vogdes 1, James Lewis 1, T. E. Streets 1, H. C. Chapman 1, Theo. D. Rand 1, Victor W. Lyon 1, R. E. C. Stearns 1, Dra. Wm. H. Green and A. J. Parker 1.

Twenty-five of these papers have been printed in the Proceedings, four have been withdrawn, and one remains to be reported upon. The Publication Committee has recommended the publica-

the morning papers, with, it is believed, the effect of increasing the popular interest in the Society.

Dr. C. N. Peirce was elected on Jan. 29 to fill a vacancy in the Council made by the election of Dr. R. S. Kenderdine as Curator.

Three members of the Finance Committee only having been elected at the annual meeting, Messrs. S. Fisher Corlies and C. S. Bement were elected on Jan. 29 to complete the number required by the by-laws.

Art. I., Chap. XII. of the by-laws was amended by substituting the words "at its first meeting" for the words "at the meeting in January."

EDW. J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

The Corresponding Secretary begs leave to present the following report of the business of his office during the year ending Nov. 30, 1878.

During the year thirty-two correspondents have been elected, all of whom have been notified.

Letters have been received from corresponding societies or other institutions transmitting their publications or acknowledging the receipt of those of the Academy, numbering 105.

Miscellaneous, individual, and circular letters, 13.

Letters from correspondents acknowledging election, 50.

During the year numerous letters of a nature too trivial to be read before the Academy have been received, and many answered. These, for the most part, have been from persons who are ignorant of the objects of the Academy, or who offer for sale undesirable objects.

In addition to letters, numerous pamphlets or books, and some manuscripts for publication, have been received, the former have been handed to the librarian, and the latter read before the Academy.

Respectfully submitted,

GEO. H. HORN, M.D.,
Corresponding Secretary.

REPORT OF THE LIBRARIAN.

The additions to the library during the last six years have been steadily increasing, the number received and recorded during the twelve months ending Nov. 30, 1878, being 2946, or 248 more than were received in 1877, and more than double the number received in 1873.

Of these accessions 477 were volumes, 2344 pamphlets and part of periodicals, and 125 maps, engravings, photographs, etc.; 2169 were octavos, 579 quartos, 62 folios, and 11 duodecimos.

They were derived from the following sources:—

Societies	1203	Bureau of Education	2
Editors	675	Jos. Ledy	2
Isaiah V. Williamson Fund	526	Pennsylvania Board of Centennial Managers	2
Authors	161	Netherland Centennial Commission	2
Wilson Fund	93	Indian Museum	1
Dr. Robert Bridges	67	James M. Magraw	1
War Department	53	Geo W. Childs	1
Geological Survey of New Zealand	29	Council of the City of Manchester	1
Publishers	21	John S. Haines	1
Department of the Interior	19	Smithsonian Institution	1
Conarroe Fund	18	Department of Agriculture	1
Geological Survey of India	11	S. S. Haldeman	1
J. H. Redfield	9	Allen B. Lemmon	1
Engineer Department, U. S. A.	6	C. F. Parker	1
Geological Survey of Pennsylvania	6	Pennsylvania Board of Agriculture	1
Minister of Public Works, France	5		

Bibliography	13	Helminthology	6
Biography	11	Encyclopædias	5
Herpetology	9	Mammalogy	4
Mineralogy	9	Useful Arts	4
Literature	6		

The large number of journals and periodicals received during the year is consequent upon the efforts which have been made to obtain supplies of deficiencies from corresponding societies and editors. Most of the societies addressed on the subject have sent such of the missing parts of their publications as they could furnish. All the new scientific journals brought to the notice of the Library Committee during the year have been obtained either by exchange or subscription.

The accessions have been catalogued immediately upon their reception, and, in addition, the catalogue of the department of general natural history has been completed, and the titles of nearly all the works on anatomy and physiology, with the exception of the pamphlets, have been entered on the cards. Reference catalogues of the departments of voyages and travels, and general natural history have been copied from the card entries by Mr. Thomas P. Parker, who has also proceeded as rapidly as possible with the numbering of the books.

For the most valuable of the monographic and special works we have again to acknowledge our indebtedness to the enlightened liberality of Mr. Isaiah V. Williamson. In the expenditure of the Williamson Fund care has been taken to order such works as are of most importance to the student, which are not, for the most part, to be found elsewhere in the city, and which give special character to the library of the Academy. All the books specially applied for by the working members of the Academy have been promptly ordered, and nearly all received.

For the reason stated in my last report, the general financial depression, but few books have been bound during the year, such expense being incurred only where it was absolutely necessary to preserve the volumes from injury.

All of which is respectfully submitted,

EDW. J. NOLAN,

Librarian.

REPORT OF THE CURATORS.

The Curators report that the Museum of the Academy continues in good state of preservation, and has steadily advanced in orderly arrangement, labelling, numbering, and cataloguing. While such is the case we take the opportunity of directing attention to what may be viewed as a serious defect in our otherwise valuable museum, one which greatly narrows its usefulness. We allude to the inequality of our collections, the incomplete collection, and almost apparent exclusion of certain departments, while others are so richly or even excessively represented. This state of things which we greatly regret is in a measure due to unavoidable circumstances. Notwithstanding the main object the Academy has had in view in forming and maintaining a museum it has never had the means to establish it in such a way as to illustrate all classes, orders, and families of natural history. The museum has grown almost entirely through the gift of its members and friends, of specimens and collections of specimens accidentally picked up or sought as the favorites of collectors. While we have thus become greatly enriched in objects of more conspicuous character, we have received comparatively few of the things of less general interest, though of great proportionate value to the

the student to read the book of nature from the beginning to end.¹

In regard to what has been done in the museum during the year we present a brief report of the able Curator in charge:—

PHILADELPHIA, Dec. 12, 1878.

DR. JOA. LEIDY,

Chairman of Board of Curators.

DEAR SIR: I herewith inclose the following report of work done in the museum during the year:

Mr. John A. Ryder has completed the re-labelling and arrangement of the Ophidians, the Saurians, and the Batrachians, and a similar re-arrangement and re-labelling of the collection of Fishes has been commenced.

The collections of mammal skins, birds, and insects have been thoroughly examined; also the alcoholic collections have been attended to, and the alcohol renewed when necessary. The re-labelling of the collection of minerals has been finished, and a numbered catalogue of the same prepared; numbers will be attached to each specimen corresponding with catalogue. The large increase of donations to this department has required the addition of six cases.

Progress is being made in the labelling and arrangement of the bird collection; this work being done by Mr. Spencer Trotter.

Most of the specimens presented, deposited, and purchased during the year have been labelled, and put in their proper places.

Respectfully, C. F. PARKER.

Besides the additions to the museum announced in special reports of Conservators of Sections, the Curators present the following list:—

The most important donations consist of a superb articulated specimen of a male Gorilla, and a young animal, in alcohol, from Ogove River, Africa, presented by Dr. Thomas G. Morton, and the original specimen of a slab of red sandstone, with foot prints of the *Sauropus primævus*, of Lea, from the lower coal strata of Pottsville, Pa., presented by Dr. Isaac Lea.

Mammals.—*Phascogaleos cinereus*, *Belidens breviceps*, *B. tasmanodes*, *Phalangista*, *Macropus* (fetus fem.), and *Ornithorhynchus anatinus*, eight specimens from Australia, presented by Dr. Clive DaCosta Belisario. *Zapus hudsonicus*, *Geomys bursa-*

¹ It may be worthy of note, that the Academy has never been able to place at the disposal of the Curators annually even a few dollars for the purchase of desirable specimens.

rins, 2 *Sorex Cooperi*, *Hesperomys leucogaster*, 2 *H. leucopus*, do. var. *sonoriensis*, *Evotomys rutilus*, 2 *Arvicola austerus*, *Peromyscus* *hispidus*, from Fort Sisseton, Dakota, Dr. C. E. Mearns, U. S. A. Nine skulls and skins of *Alouatta palliata*, *Cebus hypoleucus*, *Sapajou melanochir*, *Felis maragaya*, *Dicotyles torquatus*, *D. labiatus*, 2 *Cervus*, *Arctopithecus castaneiceps*, and *Tapirus*, from Costa Rica, Wm. M. Gabb. Mounted skeleton of Rat Kangaroo, Joseph Jeanes. *Belidens flaviventris*, Philadelphia Zoological Society. Three skulls and skin of squirrel, Wyoming, Dr. J. Van A. Carter. Tooth of sperm whale, Dr. Isaac Lea.

Birds.—A young male Bald Eagle, presented by George M. Tatham. Nest and eggs of the Snowbird, Giles Co., Va., Dr. H. Haupt, Jr. Six bird skins from Brazil, Mr. Sarmiento. Eggs of *Penelope grayi*, Geo. Pavonarius. Nests of American Goldfinch and Indigo birds, J. O. Shimmel.

Reptiles and Fishes.—Two *Jacare*, *Thrasops albaetulla* and *Elaps*, from Brazil, Mr. Evans. Two jars of snakes, from Alabama, Dr. Joseph K. Corson. Skin of Boa, from Brazil, Mr. Sarmiento. Two *Ophibolus dolatus*, S. P. Monks. Shed skin of *Coluber*, John A. Krider. *Tropidonotus leberis*, R. C. Davis. Limb bones of the Leather Turtle, New Jersey, John Ford.

Twenty-seven bottles with fishes, etc., obtained during a cruise of the U. S. ship Portsmouth, 1872-75, in the Pacific; also a minute Balloon Fish from the Pacific, presented by Dr. W. H. Jones, U. S. N. *Amphioxus lanceolatus*, from Mediterranean, Dr. H. E. Hensley.

II *Alomitra pileus*, Sandwich Islands, W. S. Vaux. Sertularia and
3 species Sponges, Fortress Monroe, N. C., from S. Powell.


Fossils.—Two large frames, with fossil foot-prints, from Con-
necticut; slab of Triassic shale with rain-drop marks and sun-dried
cracks, from Gwynedd, Pa.; *Pentacrinus briareus*, from lias, Eng-
land, Dr. Isaac Lea.

Molar of Mastodon, from York Co. Pa., Mr. Snyder. Bones of
Crocodile, etc., near Hornerstown, N. J., T. A. Conrad. Sharks
teeth, vertebrae, shells, echinoderms, etc., from the marl of Vin-
centtown, N. J., C. B. Barrett. Crinoids from Canton, Ohio, and
Crawfordsville, Indiana, J. W. Pike. *Doryerinus mississippiensis*,
Keokuk, Iowa, Gen. W. W. Belknap. *Clupea humilis*, from ter-
tiary of Wyoming, Dr. Joseph Leidy. Cetacean bones, Miocene
of Va., Prof. Jeffries Wyman. Fossil wood, numerous *Eudea dic-*
hotoma, and 2 rock specimens, Col. T. M. Bryan. *Favosites*
niagarensis, Jackson Co., Ky., W. S. Vaux. Vertebra of a
Plesiosauroid, Arkansas, Dr. G. W. Lawrence. Molar of Bison
and rib fragments of Manatee, from near Tallahassee, Florida,
Prof. S. S. Haldeman. Bones of deer, bear, weasel, etc., from a
cave, Bedford Co., Pa., Mr. Wm. Hartley.

Ethnological and Miscellaneous.—Indian axe, Moorestown, N. J.,
E. D. Stokes. Carved drinking cup, from Fiji Islands, Dr. J. P.
Bethell. Plaster model of the great pyramid of Cheops, from Wm.
H. French; and water-proof coat, made from the intestines of
bear, Alaska, Dr. W. H. Jones. Terra-cotta head, found near
Natchez, Tenn., and fragments of stone axes, Haldeman Co.

head-dress, skin pouch, Cassava grater, three native baskets, one used for carrying children, etc., on the back, from British Guiana; two marten skins, dressed by the Ute Indians, from Colorado; stone adze, with carved handle, New Zealand; do. Hawaii, Sandwich Islands; rattles, "Shak-shak," used by the Caribs in dancing, paddle, used also as war club and seat, sandals, and carved rattles, from British Guiana; shield of "Roaring Bull," a Comanche chief, scalp of a Comanche Indian, do. of a Modoc Indian, tanned squirrel skin, Idaho; saddle-blanket, made by the Navajo Indians of northern New Mexico; feather head-dress, of the Macusi Indians, of British Guiana; boat with open ends, used to navigate dangerous rivers, made of a single piece of bark, by the Accawois tribe of Indians, British Guiana; a collection of the manufactures of the Indians of British Guiana, consisting of two fans, two wicker trays, two baskets, Matapi, or Cassava squeezer, three bark shoes, sail of the pith of the Ite palm, maquani, or whips, bow, and stone-pointed arrows, blow-gun, and poisoned arrows, two canoe paddles; bamboo fiddle, with bow, drum and sticks, child's hammock, material for making hammock, watsapura, or flute, rattle of a dancing pole, candle, etc., from British Guiana; and a hat, native work of Hawaii, Sandwich Islands, presented by Prof. S. S. Haldeman.

Cast of face, from a mound, Greenup Co., Kentucky, from W. R. Mercer. Indian stone axe, Ashley River beds, South Carolina, from Geo. C. Lewis. Fragment of Indian pottery, containing crushed tourmaline, do. having the appearance of being marked with an eye of corn. Iredell Co., N. C. fragments of human jaw



Agate, and Geode of Limonite, Argentine Republic, Moses A. Dropsie. Twenty-five Amygdaloid rocks, from Scotland, Prof. J. Duns. Barite, Brown Co., Kansas; Magnesite, Texas, Lancaster Co., Pa., Prof. A. E. Foote. Vermiculite in Chlorite schist, Dolomite with Apatite and Tale, Steatite Quarry, above Manayunk, Pa., John Ford. Hematite, Morgantown, N. C., Col. B. S. Gaither. Olean oil, McKean Co., Pa.; Lubricating oil, Wood Co., W. Va., Morris W. Harkness. Indurated Tale, Black Horse, E. Bradford, Chester Co., Pa., W. D. Hartman. Limonite, Marble Hill, Montgomery Co., Pa., Russell Hill. Two fine specimens of Corundum, Hog-back Mt., Jackson Co., N. C., Joseph Jeanes. Emerylite, Jefferisite, Oligoclase, and Corundum, Newlin, Chester Co., Pa., W. W. Jefferis.

Magnesite in Serpentine with Chlorite, Putnam Co., N. Y.; Chlinochlore, Chester Co., Pa.; Oolitic Marble, Leavenworth, Indiana; Black and Crinoidal Marble, Actinolite, Glacier Roseg, Switz., Dr. Isaac Lea.

Forty-six minerals, and eight rocks, consisting of the following: Spinel in Chlorite, light-brown Tourmaline, green ditto in Granite, Corundum, Chlorastrolite in Trap, Hydrodolomite with Serpentine and Chromite, Deweylite, nodules of Geyserite, Efflorescence of Salt, group of Quartz crystals, Glauberite, Turquoise, pale Rubellite in decomposing Albite, Corundum with partial metamorphosis into Ripidolite, ditto in Ripidolite and blue Corundum, Zinc Staurolite, Quartz with Sard, Quartz found with Apatite, Hyalite, Garnet, flattened crystal in Muscovite, calcareous Tufa, Muscovite, Menaccanite, Flint, Brookite, Jade, Calcite, Hercynite pseud. after Corundum, Feldspar associated with Corundum, Ceylon, Chlorite from Franklin, Macon Co., N. C., Orthoclase containing Quartz crystals, Biotite schist, Aragonite, Cypoline, etc., presented by Dr. Jos. Leidy.

Thirty-six minerals, and forty-four rocks from various localities, consisting of Phyllite, Bronzite, Stibnite, Topaz passing into Margarodite, Nuttabergite, Tourmaline, Apophyllite and Stilbite, Calcite, Albite, Hypersthene and Pyrrhotite with Quartz, Kainite, Kieserite, Stassfurtite, blue Quartz, Delawarite, Cassinite, Lenaxite, Hyalite, Molybdenite, Apatite in Tale, Velvet Limonite, Chalcopyrite in Gneiss, Tremolite, Oligoclase, Topaz, Willemite, Gneiss with Lime Uranite, Pyrite, Idiocylophanous Calcite, Malachite, Chlorite, and Antholite, etc., Theo. D. Rand.

Calcite, Geode of Quartz, ditto of Chalcedony, from Keokuk, Iowa, Dr. J. M. Shaffer and Hon. C. F. Davis. Limonite, Gneiss, Manganese, from Morgantown, N. C., Col. T. G. Walton. Sphene, Pyroxene, Hornblende, white Augite, Serpentine, Gurbotte, Pyrite, Trap, etc., S. A. Monks.

Meteorite, N. C.; Corundum, Muscovite, Quartz, Apatite, Staurolites, pseudomorph Quartz, Biotite, Jeffersonite, Sussex Co. N. J.; Orthoclase, Galenite with Blende, Rutile in Quartz, Alexander Co., N. C., Joseph Willcox.

Fine large specimen of Lilac Fluor Spar, Cumberland, England, Wm. S. Vaux.

Calcite, St. Louis, Mo.; Tourmaline, Warren, N. H.; Apatite with Feldspar and Epidote, Jefferson Co., N. Y.; Chilenite, Chili, in exchange.

Dufrenite, Lava, from Vesuvius; two crystals of smoky Quartz, two Fluorites, six crystals of Amazon Stone, one cluster of crystals of ditto, from Pike's Peak, Col.; Rutile, Lincoln Co., Ga.; Moonstone, Del. Co., Pa.; Arkansite, Hydrotitanite, Perovskite, ditto Cubo-octahedrons, from Magnet Cove, Ark.; Elæolite, Ozark Mts., Ark.; Stilbite, Phila., purchased.

Respectfully submitted by

JOSEPH LEIDY,

Chairman of Curators.

REPORT OF BIOLOGICAL AND MICROSCOPICAL SECTION.

All the members of the Academy are cordially invited to attend them.

The membership of the Section is nearly 80. Two were added, one died, and four resigned during the year.

Nine contributors have also been added to the list.

A Zentmeyer histological stand, and numerous accessories, together with several histological specimens, have been purchased.

On December 2d, the following were elected officers for 1879:—

<i>Director</i>	.	.	.	.	R. S. Kenderdine, M.D.
<i>Vice Director</i>	.	.	.	.	J. H. M'Quillen, M.D.
<i>Recorder</i>	.	.	.	.	J. Hess, M.D.
<i>Corresponding Secretary</i>	.	.	.	.	J. N. Peirce, D.D.S.
<i>Conservator</i>	.	.	.	.	J. G. Hunt, M.D.
<i>Treasurer</i>	.	.	.	.	I. Norris, M.D.
<i>Curators</i>	.	.	.	.	Carl Seiler, M.D. Charles Zentmeyer, M.D.
<i>Auditors</i>	.	.	.	.	S. Fisher Corlies, Charles Perot, Charles Dixon, M.D.

Submitted for the Section,

R. S. KENDERDINE, M.D.,

Director.

REPORT OF THE CONCHOLOGICAL SECTION.

The Recorder of the Conchological Section respectfully reports that, during 1878, the following authors have contributed papers which have been published in the Academy's Proceedings:—

C. A. White, 3 pages.	James Lewis, M.D., 2 pages.
Cones & Yarrow, 3 pages.	Mazyck & Vogdes, 1 page.

In addition to these, several verbal communications of value have been made before the Academy by Prof. Joseph Leidy, Mr. John Ford, and others.

Death has again visited us, and taken from our number our much esteemed and valued Vice Director, William M. Gabb.

During his short but very active life as an explorer, author, and collector, Prof. Gabb made extensive collections, most of which are deposited in our museum; and contributed many valuable

papers, upon both fossil and recent conchology, to the "American Journal of Conchology," Journal and Proceedings of the Academy and other scientific periodicals.

At the time of his death, he had just completed an elaborate essay on the fossil Mollusca of Central America, illustrated 80 drawings made by himself, which is now in the hands of the proper committee for publication in the Journal of the Academy.

From the report of our Conservator, we find that the additions to the museum, all of which have been labelled and arranged in the cases, aggregate 725 trays, 1570 specimens.

Of the "Robert Swift" cabinet, the non-operculate land shells have been labelled and arranged in 3933 trays, 18,348 specimens making a total of 4658 trays, and 19,918 specimens. Adding these to the totals of former years, we have the following as the present census of the museum (recent shells only):—

Total number of trays,	34,638
Total number of specimens,	119,918

Our Conservator says: "The additions of the current year have all been cleansed and mounted by the experienced hands of Mr. Charles F. Parker, who has as usual freely devoted to this purpose a large portion of his time not occupied by his official duties as Curator. He has also labelled and mounted the fossil shells presented during the year. The unscientific separation, in our museum, of the fossil from the recent shells is much to be regretted."

- .. Conrad (dec'd). Eight species of marine and fresh-water shells.
- ! Ford. Fossil oyster, from the Hadrosaurus marl-pit, Had-donfield, N. J.
- Egg cases of *Sycotypus canaliculatus*, L., Atlantic City, N. J.
Petricola pholadiformis (in situ), and fine group of *Mytilus edulis*, from Cape May, N. J.
- Crepidula fornicata*, L., Long Island Sound.
- Mytilus hamatus*, Say, Princes' Bay, N. Y. harbor.
- Petricola pholadiformis*, Atlantic City, N. J.
- . M. Gabb (dec'd). Thirty-three species of Tertiary mollusca, collected in the West Indies, by R. J. L. Guppy; one hundred and eighteen species of miocene and pliocene shells, 80 of which are types of new species, from Costa Rica: also a small collection from San Domingo.
- Gabb. Terrestrial shells, collected in San Domingo, by the late Wm. M. Gabb.
- ry Hemphill. A collection (139 species) of land and fresh-water shells made by him in Utah. (In exchange.)
- Hergesheimer. *Gyrodes*, from Budd's Ferry, Lower Potomac, Va.
- sell Hill. *Natica aurantia*, Lam.
- Geo. H. Horn. Five species (numerous specimens) of land shells from Polynesia.
- W. H. Jones, U. S. N. A number of specimens of mollusks in alcohol, collected during a cruise of the U. S. ship Portsmouth in the Pacific, 1872-5.
- Geo. W. Lawrence. *Baculites*, *Ammonites*, three *Gastropods*, and a *Lamellibranch*. from Clark County, Ark.
- ry C. Lea. Types of 100 species of tertiary fossils, described by him.
- c Lea. Two large *Ammonites*.
- Joseph Leidy. *Donax fossor*, Say, (numerous specimens), from Cape May, N. J.; *Maestra solidissima*, Chemn., bored by *Natica heros*, Say, Atlantic City, N. J.
- urles F. Parker. *Nautilus pompilius*, L., a fine section, showing the chamber partitions and siphon tubes.
- in S. Phillips Fund. 533 species of shells (795 specimens), all new to the Academy's collection.
- a. Rigglin. *Marginella apicina*, Mke., from Sarasota Bay, Fla.

Dr. W. S. W. Ruschenberger. Three species of shells from Apia, Island of Upolu, Navigators' Group.

John H. Redfield. Twenty-eight species of post-pliocene shells, from California.

S. R. Roberts. *Anodonta implicata*, Say, and *A. fluviatilis*, Dillw.

R. Swift Fund. Thirty-six species of post-pliocene fossil shells, from California.

G. W. Tryon, Jr. Eighteen species of Californian post-pliocene shells.

Wm. S. Vaux. One hundred and eighty species of post-pliocene and cretaceous shells, from California.

L. C. Wooster. Three species of land shells, from the alluvium of Cache-la-poudre River, Greeley, Colorado.

The officers of the Section for 1879 are :—

Director W. S. W. Ruschenberger.

Vice Director . . . John Ford.

Recorder S. Raymond Roberts.

Secretary E. R. Beadle.

Treasurer Wm. M. Mactier.

Librarian Edw. J. Nolan.

Conservator Geo. W. Tryon, Jr.

Respectfully submitted,

S. RAYMOND ROBERTS,

Recorder.

members by death, viz., Mr. Robert Frazer, formerly President of the American Entomological Society, and Mr. Edward Tatnall. The private collection of the latter gentleman has been placed in the care of the American Entomological Society, which purposes to make use of the same, as a nucleus for the formation of a general collection for exhibition in the Museum of the Academy, if proper accommodations can be obtained. Such a collection must necessarily be solely for display, as it would be neither expedient nor safe to expose a valuable collection, such as is now contained in the cabinet of the Entomological Society, to the dangers of destruction.

Owing to the failure of the invested fund of the American Entomological Society to produce so large an income as in previous years, the Society has been compelled to limit its expenditures to a much smaller amount. Consequently the publications have not been so large as they otherwise would have been. Only five written communications, therefore, have been passed by the Publication Committee. Four of these contained descriptions of Coleoptera, by Dr. George H. Horn, and the other descriptions of Hymenoptera, by Mr. E. T. Cresson.

In the month of September, with consent of the Council, an extra heat coil was placed in the room occupied by the Section, the latter bearing the expense thereof.

Much time and labor have been devoted, during the past year, to the improvement of the collections. This is particularly noticeable in the collection of Hymenoptera, which has greatly increased by the addition of new and rare species derived more especially from Colorado and Nevada. The collection of Hymenoptera now within the walls of the Academy is, beyond all doubt, the finest and most valuable of that order in America, and is probably the best collection of North American species to be found in the world.

Great advances have also been made in filling up vacancies in the orders of Coleoptera and Lepidoptera, and the collections of both have been rendered more valuable.

New methods have been adopted, by which the drawers of the cabinets may be readily fumigated, and it is hoped by the greater facility thus obtained of reaching all specimens, the loss from infection will be greatly diminished.

The remains of the original collection of the Academy have also

been attended to by the members in charge, and the loss from decay greatly lessened. This collection had already suffered to such an extent, that when it came under the supervision of the Section it was found to be of but little or no value as a scientific collection. What typical specimens it ever contained that were of special importance had been destroyed or transferred to other places, and the remainder was on a sure course of destruction for want of care. Under these circumstances the Section placed it under lock and key, and while bestowing upon it all the care of which it is in need, reserves it for use in the museum with such other specimens as may, from time to time, be added thereto.

When it is considered that the gentlemen who have in charge the Entomological Collection now in this building, have no leisure from their daily avocation, and are compelled to devote their evenings to the work, it will be realized that progress must necessarily be slow; but, for the first time in the history of the Academy, the collection is now safe beyond depredations of any sort.

At the meeting of the Entomological Section, held December 9th, the following named persons were elected officers for the year 1879.

<i>Director</i>	John L. LeConte, M.D.
<i>Vice Director</i>	George H. Horn, M.D.
<i>Recorder</i>	J. H. Ridings.
<i>Treasurer</i>	E. T. Cresson.
<i>Publication Committee</i>	George H. Horn, M.D.

month during the year, August excepted. At these meetings verbal communications have been made by Prof. Rothrock and Messrs. Redfield, Stevenson, Potts, Canby, Burk, Martindale, Scribner, Griffith, and Meehan. Of these, Mr. Stevenson's, on the *Valsei* of the United States, Mr. Griffith's, on *Aspidium aculeatum*, and Mr. Potts's, on the mechanism of the flowers of *Stapelia* and *Asclepias*, have been accepted for publication in the Proceedings of the Academy. Some of the other more important matters introduced to the notice of the Section have been reported to the general meetings of the Academy, and published by the general committee in its proceedings.

The report of the Conservator gives so clear an account of the condition of the Herbarium, that it is submitted entire, and while the vice director is sure the Academy will be gratified with the account of the progress made, he may take occasion to say that the good work is mainly due to Messrs. Redfield, Burk, and Schimmel, with such occasional assistance as Prof. Rothrock, Mr. Scribner, the writer of this, and Mr. Parker, outside of his duties as curator of the Academy, were able to render.

The officers elected at the last meeting, to serve for the ensuing year, are:—

<i>Director</i>	Dr. W. S. W. Ruschenberger.
<i>Vice Director</i>	Thomas Meehan.
<i>Recorder</i>	Isaac Burk.
<i>Corresponding Secretary</i>	Isaac C. Martindale.
<i>Conservator</i>	John H. Redfield.
<i>Treasurer</i>	Jose O. Schimmel.

Respectfully submitted,

THOMAS MEEHAN,

Vice Director.

Conservator's Report.—Since the last annual report of the Conservator was made to the Botanical Section, the work of arranging the plants of the Herbarium in genus-covers has been completed, and the collection is now in a condition to be accessible and useful to students. The preparation of order tablets for the general Herbarium is suspended for the present, awaiting the appearance of the next portion of Bentham and Hooker's *Genera Plantarum*.

The additional case needed for the North American Herbarium

has been provided by the Academy, and the space now at our disposal, though none too large, enables us to make a creditable and convenient display of our present representation of the Flora of North America. Mr. Isaac Burk has kindly devoted such time as he could command to the arrangement of this part of our collection, and to the distribution in their places of the new accessions. The preparation of the order tablets is now being rapidly pushed to completion, in which work we have had essential assistance from the Academy's efficient curator in charge, Mr. Charles F. Parker.

In proportion as the pressure of this preliminary work has abated, we have been enabled to give some attention to the important task of revising and elaborating the abundant and rich material of our collections. As already reported to the Section in fuller detail, the Conservator has, during the year, worked up the Ferns of both the General and North American Herbaria, and these are all now properly determined, labelled, and mounted, numbering over nine hundred species. Those of Dr. Short's Equatorial Herbarium yet need an examination and revision. This will soon be undertaken, and when completed the Conservator hopes to present a catalogue of this division.

Mr. M. S. Bebb, who has for many years made a specialty of the study of the North American willows, and who is now engaged in elaborating their species for the Flora of North America, and for the Botany of California, having kindly offered to make a critical examination of this difficult and perplexing genus, the Academy authorized us to accept his offer, and he has carefully

tion of our collection, and has already entered upon the work, and from the careful, thorough, and conscientious study which he is giving to it, we may expect the best results.

In all these revisions the original determinations and tickets are carefully preserved, together with the notes of the revisor, whose work can, therefore, at all times be tested.

We should add that Mr. Sereno Watson, of the Cambridge Herbarium, has revised for us the species of *Cupressus* and *Iris*, detecting many errors, and supplying valuable notes.

It is to be hoped that thus in time the aid of specialists will bring order out of confusion in other portions of our collection.

In the month of April the Academy received a large collection of plants consisting of nearly three thousand species, mostly European and East Indian, from the Herbarium of the late John Stuart Mill. These were presented by Miss Taylor, through the director of the Royal Gardens, Kew, and were obtained through the kind offices of Dr. Asa Gray.

From Prof. George E. Post, of the American Protestant College, Beirut, Syria, has been received in return for Colorado and Utah plants furnished by the conservator, upwards of four hundred species from the maritime and mountain districts of Syria, and from Algeria, of which nearly one-half were new to our collection, and further accessions are promised from the same source.

All of these large additions, with others specified in the annual list of donations, have been thoroughly poisoned by Mr. Charles F. Parker, and their distribution to the proper places upon our selves, has made large demands upon the time and labor of the Herbarium Committee, and these demands have been promptly and cheerfully met.

Additions to Botanical Museum and Herbarium, 1878.

Dec. Isaac C. Martindale; cones and twigs of *Pinus mitis*, Mx., collected by him near Moorestown, New Jersey, and 50 species of phanerogamous plants from New Zealand.

A. L. Siler, of Osmer, Utah, through Mr. Meehan; foliage and cones of *Pinus aristata*, Engelm.

John H. Redfield; 15 species of plants from Utah and California, mostly new to the collection.

March. A. Commons, Centreville, Del.; *Galium hispidulum*, Mx., from Cape May, New Jersey—the first notice of it in that State.

C. F. Parker; *Pogonia affinis*, Austin, from Closter, N. Y., and *Pyrola oxypetala*, Austin, from Deposit, N. Y.—the author's type specimens with his original notes attached.

April. M. S. Bebb, Fountaindale, Ill.; 13 species of North American willows.

Dr Asa Gray, Cambridge, Mass.; about 3000 species of European and East Indian plants from the herbarium of the late John Stuart Mill, presented by Miss Taylor, through the director of the Royal Gardens, Kew.

Do.; 168 species of plants from China, India, Australia, California, etc., mostly new to the collection.

John H. Redfield; 22 species of flowering plants from Southern Utah, and 20 species ferns, mostly new to the collection.

Charles F. Parker; *Schizæa pusilla*, Pursh, from Toms River, New Jersey, and *Botrychium lanceolatum*, from Closter, N. Y.

Isaac C. Martindale; *Bromus brevi-aristatus*, Wats., from S. W. Utah.

May. Conchological Section of the Academy; 54 species of Californian marine algæ, collected by Henry Hemphill.

September. Dr. Asa Gray, Cambridge, Mass.; 160 species of plants, mostly from Oregon and California.

Prof. Joseph T. Rothrock; a suite of the collections made by himself and Prof. John Wolf, on Col. Wheeler's explor-

Florida, by Mary C. Reynolds; and *Camptosorus rhizophyllus*, collected on Round Top, battle-field of Gettysburg.

December. Thomas Meehan; *Polypodium falcatum*, Kell., and *Oenothera graciliflora*, collected by Mrs. Briggs in Washington Territory.

T. S. Brandegee, Canon City, Colorado; 8 new species of Fungi from Colorado, named by Prof. Peck.

REPORT OF THE MINERALOGICAL SECTION.

The Director of the Mineralogical Section of the Academy of Natural Sciences would respectfully report, that meetings of the Section have been held every month except July and August; the attendance has been fair. At nearly every meeting new facts of importance have been brought forward and discussed, so that there has been no lack of interest.

The donations for the year have been numerous, and many of them valuable. The items will be found attached to the report of the Curators of the Academy.

The increase of the cabinet may be deemed entirely satisfactory.

The Director would also call attention to the fact that a full catalogue of all the minerals in the collection has been made by Mr. Charles F. Parker during the year, who also has completed the relabelling of all the specimens, works of great labor most satisfactorily performed. In addition to this, Mr. Parker has prepared a list of minerals lacking in the collection. By distribution of this, it is believed many of the vacant spaces may be filled by gifts of the needed species.

Some progress has been made in the local collection of rocks and minerals, but much remains to be done. It is purposed to make a list of desiderata in this collection for distribution.

By voluntary contribution of members of the Section, a Campbell Trimmer has been purchased and presented to the Academy.

Several new localities of minerals have been for the first time announced through the Section.

Respectfully submitted,

THEO. D. RAND,

Director.

The election of Officers for 1879 was held in accordance the By-laws, with the following result:—

<i>President</i>	. . .	W. S. W. Ruschenberger, M.
<i>Vice-Presidents</i>	. . .	Wm. S. Vaux, Thomas Meehan.
<i>Recording Secretary</i>	. . .	Edward J. Nolan, M. D.
<i>Corresponding Secretary</i>	. . .	George H. Horn, M. D.
<i>Treasurer</i>	. . .	William C. Henszey.
<i>Librarian</i>	. . .	Edward J. Nolan, M. D.
<i>Curators</i>	. . .	Joseph Leidy, M. D., William S. Vaux, Charles F. Parker, R. S. Kenderline, M. D.
<i>Councillors to serve three years</i>	. . .	Edward S. Whelen, C. Newlin Peirce, J. H. Redfield, S. Fisher Corlies.
<i>Finance Committee</i>	. . .	Edward S. Whelen, Clarence S. Bement, Aubrey H. Smith, S. Fisher Corlies, Geo. Y. Shoemaker.

August 27.—Dowling Benjamin, M. D.

September 24.—E. Glybbon Spilsbury, Henry A. Green, Francis S. Percum, M. D., Henry C. Wood, M. D.

October 29.—William Ayres, William T. Haines, J. Bernard Rinton, M. D., Edmund Lewis.

November 26.—J. Ward Atwood, M. D., Wm. S. Baker, Dr. L. Ashley Faught.

CORRESPONDENTS.

January 29.—John McCrady, of Sewanee, Tenn.; Charles Minot, of Roslindale, Mass.; Henry Hicks, of London; J. W. Hulke, of London; Thomas Belt, of London; H. G. Seely, of London; W. T. Thistleton Dyer, of London; Archibald Geikie, of Edinburgh; James Geikie, of Edinburgh; Charles Barrois, of Lille; Dr. M. E. Jannettaz, of Paris; Dr. Emil Sauvage, of Paris; Ch. Velain, of Paris; Edmond Pellat, of Paris; H. Filliol, of Paris; Michael Vacek, of Vienna; Karl von Seebach, of Göttingen.

February 26.—J. Gozzardini, of Bologna; G. Meneghini, of Pisa; Antoine Stoppani, of Milan; Francisco Coello, of Madrid; Dr. J. J. Steenstrup, of Copenhagen; F. Steenstrup, of Copenhagen; R. Brough Smyth, of Melbourne; Edward Van Beneden, of Liege; Jules Küncel d'Herculais, of Paris.

March 26.—Auguste Forel, M. D., of Munich; James Wood Mason, of Oxford.

May 28.—Gumesindo Mendoza, of Mexico; Stephen Bowers, A. M., of Santa Barbara, Cal.

July 30.—J. B. Ellis, of Newfield, N. J.

November 26.—R. Neilson Clark, of Rosita, Col.

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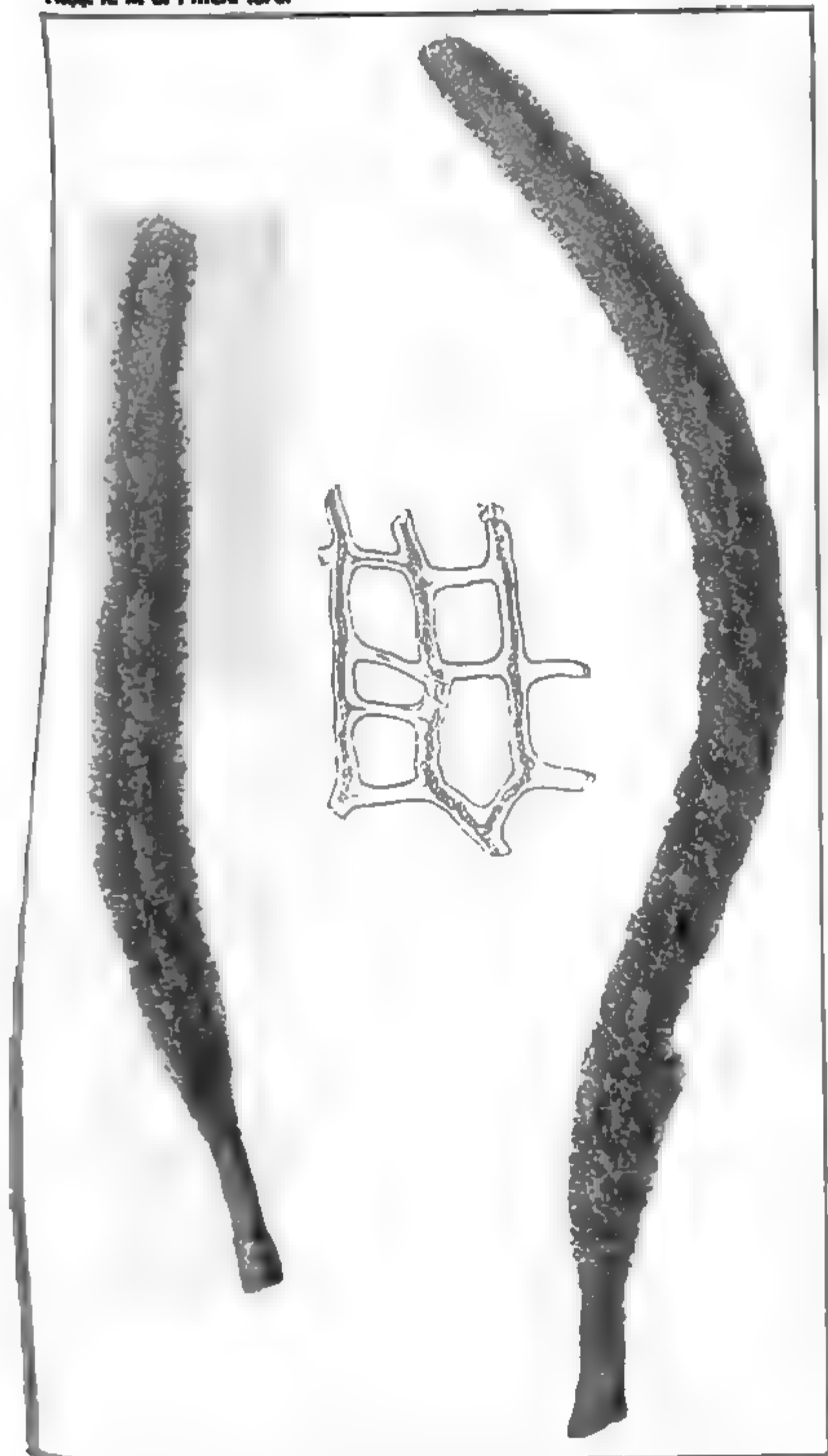
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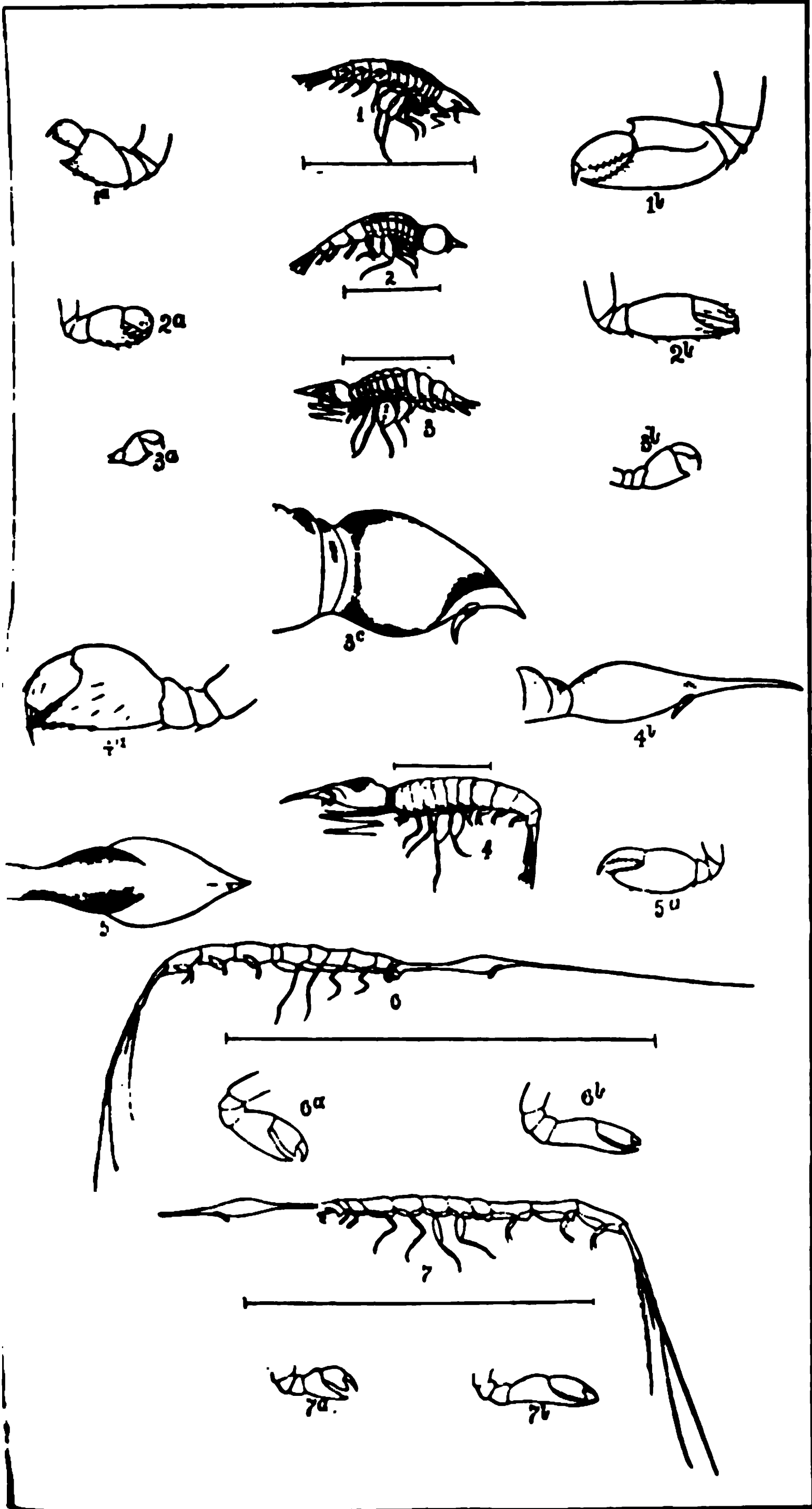
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APLYSINA PEDICELLATA, HYATT. (37)



• STREET DEL.

STREETS ON PELAGIC AMPHIPODA.



CHAPMAN ON THE GORILLA.

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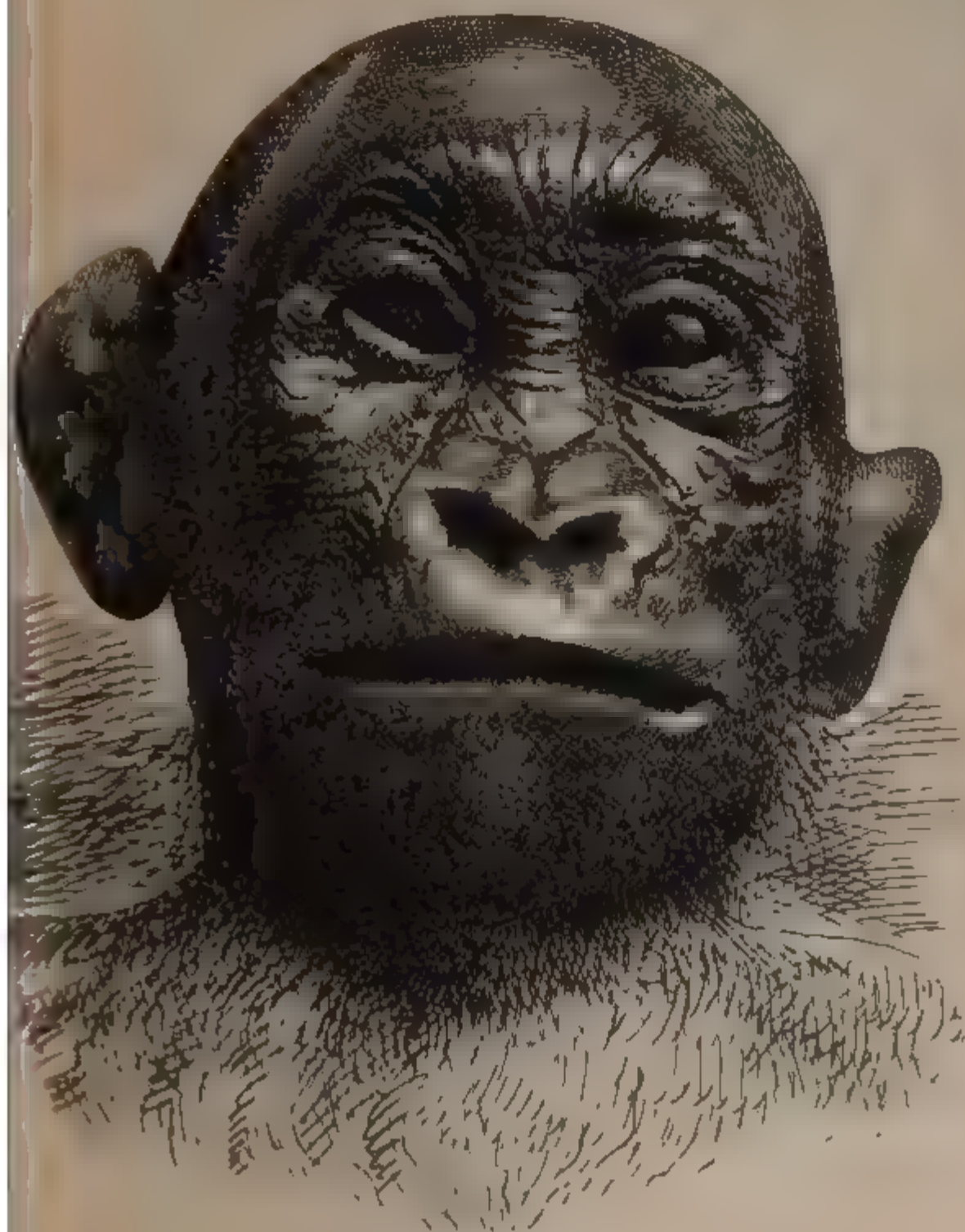
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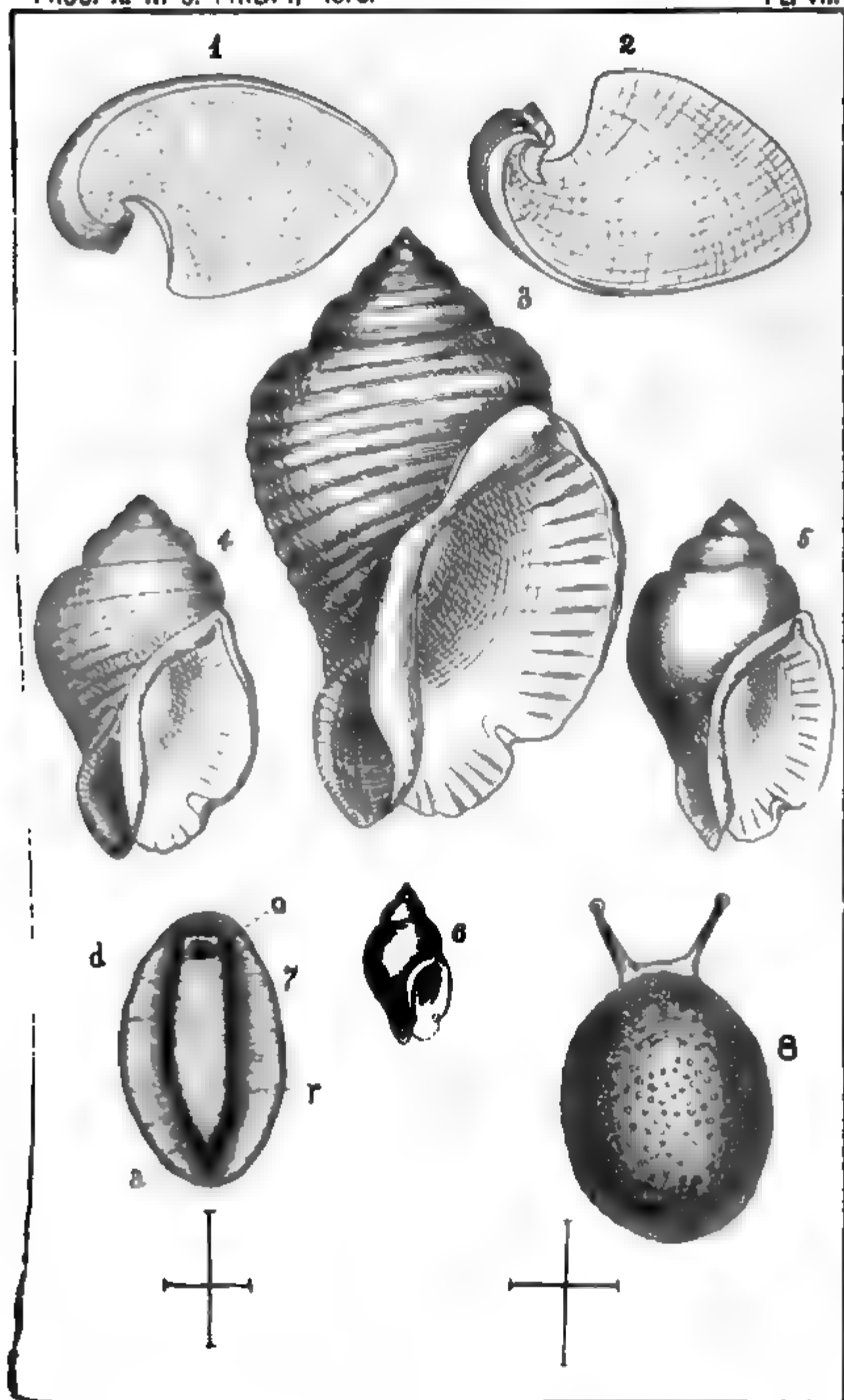
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ROC. A. N. S. PHILA°. 1878.

PL. IV.



CHAPMAN ON THE GORILLA.



PROCEEDINGS
OF THE
ACADEMY OF NATURAL SCIENCES
OF
PHILADELPHIA.

1879.

PUBLICATION COMMITTEE.

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GEO. H. HORN, M.D.,

WM. S. VAUX,

THOMAS MEEHAN,

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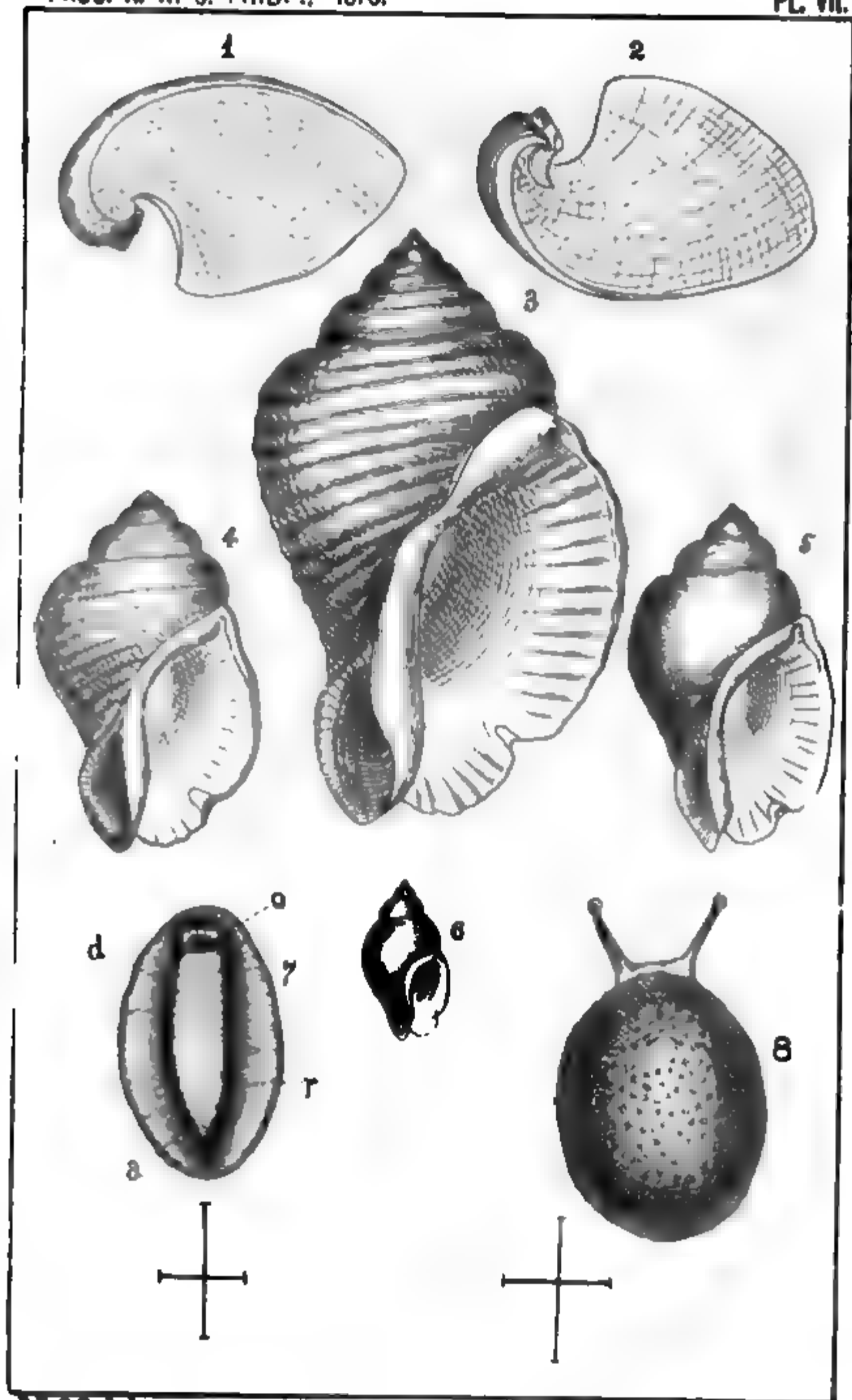


PLATE VII.

STEARNS ON WEST COAST SHELLS.

PROCEEDINGS
OF THE
ACADEMY OF NATURAL SCIENCES
OF
PHILADELPHIA.
1879.

PUBLICATION COMMITTEE.

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PHILADELPHIA.
ACADEMY OF NATURAL SCIENCES,
N. W. Corner Nineteenth and Race Streets
1880.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA,
March, 1880.

I hereby certify that printed copies of the Proceedings for 1879 have been presented at the meetings of the Academy, as follows:—

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"	25 to 56	April	15, 1879.
"	57 to 136	May	13, 1879.
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"	153 to 184	August	12, 1879.
"	185 to 200	November	4, 1879.
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"	217 to 230	January	6, 1880.
"	231 to 376	February	17, 1880.
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EDWARD J. NOLAN,
Recording Secretary.

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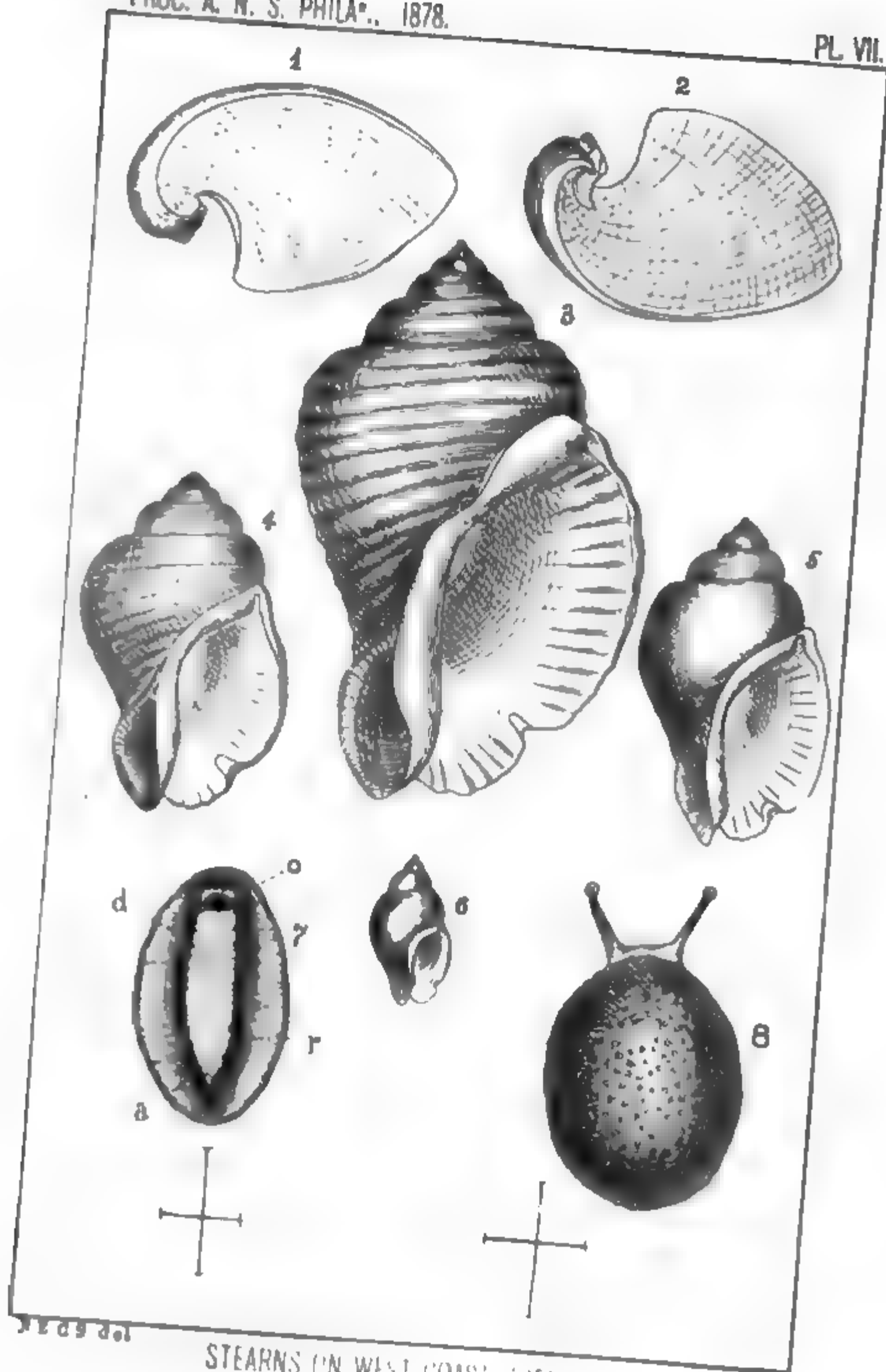
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STEARNS ON WEST COAST SHELLS.

and sincere seeker for truth, whose attainments in knowledge were so broad, and so diversified, as to command our respect and admiration, and whose large and loving heart was so manifest in all his deportment and intercourse with us, as to win our esteem and affection. We, therefore, join our sympathies with all those who have been bereft of his instruction, his example, and his fellowship, and we direct that these sentiments be placed upon our records, and a copy of the same be transmitted to the family of the deceased.

JANUARY 21.

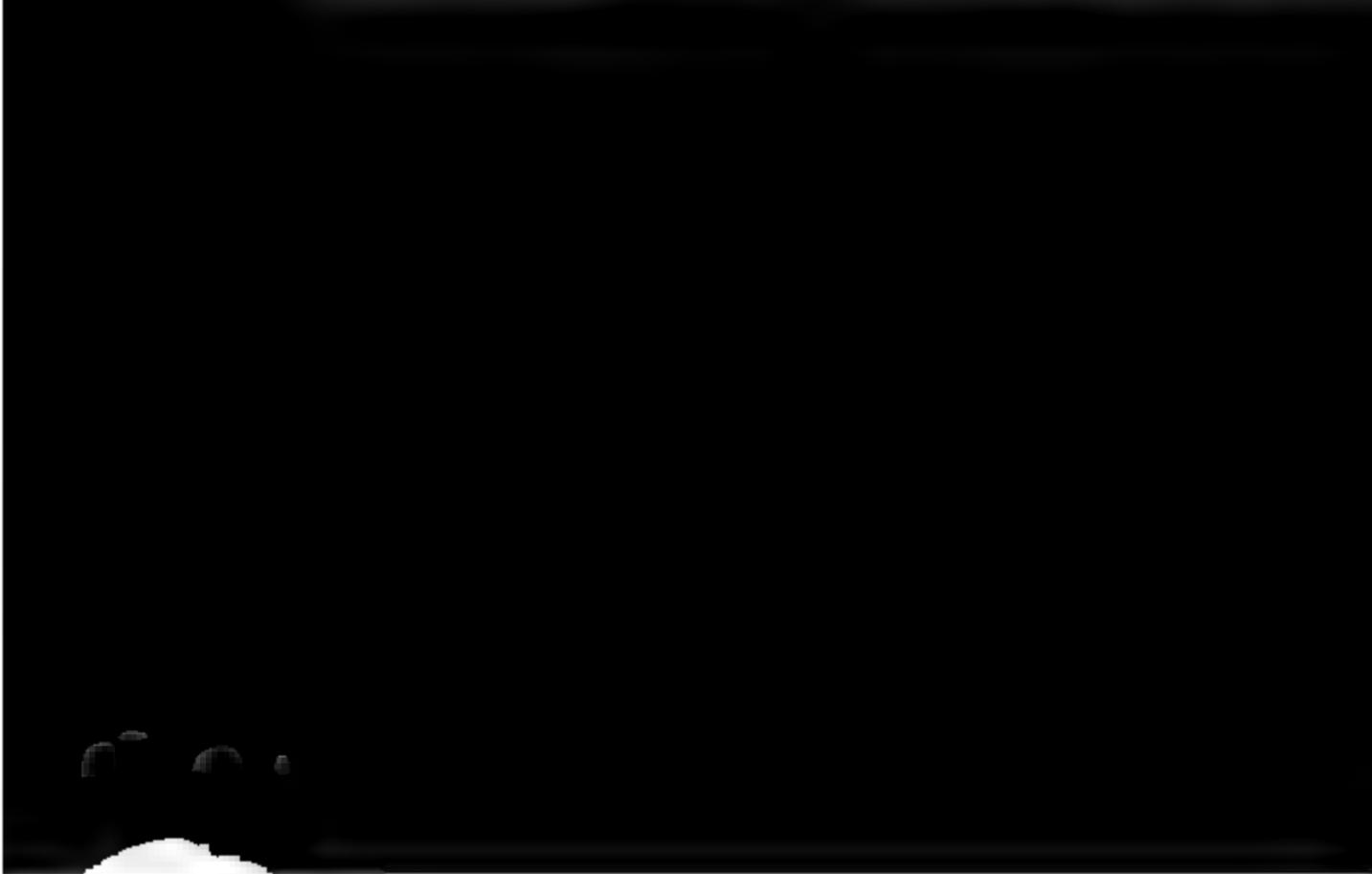
The President, Dr. RUSCHENBERGER, in the chair.

Thirty-four persons present.

A paper entitled "Notes on some Pacific Coast Fishes," by W. N. Lockington, was presented for publication.

Solidago odora as a "Tea" Plant.—Mr. THOMAS MEEHAN drew attention to some samples of dried leaves that had been sent for identification, and which are represented to be in extensive use in Berks Co., Pa., as a beverage under the name of "Blue Mountain Tea." Mr. Meehan found the leaves to belong to *Solidago odora*. The infusion had a slight taste of fennel, by no means disagreeable, but yet with little more attractions than catnip, or any ordinary "herb tea," might present.

JANUARY 28.



generally of much lighter color, and more robust character than the males. In both sexes the body is most attenuated anteriorly, but in the female the body is nearly as thick at the posterior extremity as it is at the middle. Some of the smaller males are pale brownish-white, but most of them, from the smallest to the largest, are of various shades of brown to chocolate-brown. The females are pale brownish to darker brownish. In both sexes the head forms a convex, whitish eminence, encircled by a narrow black ring, from which a band of brown extends dorsally and ventrally along the body. The posterior end of the body is likewise of darker color than the part just in advance.

The tail of the male makes a spiral turn inwardly, and is furcate. The forks are short, curved, slightly divergent, blunt conical processes. Just in advance of their conjunction internally, there exists an inverted crescentic fold of browner color than the contiguous parts, and immediately in advance is the genital pore. The interval of the caudal forks is smooth, or free from papillæ.

The tail of the female appears truncated; is bluntly rounded, feebly clavate, or slightly thicker than just in advance, and nearly as thick as the middle of the body. It presents a terminal pore, marked by a brown spot, and encircled with a brown ring.

Under a moderate magnifying power, the brown integument is minutely mottled with whitish spots, and it exhibits fine longitudinal and diagonal striation. In sunlight it is beautifully iridescent as in the earth-worm.

The worms are still quite lively. When disentangled and left alone they soon become again knotted together in a compact rounded mass as at present, with the heads divergent, and writhing so as to remind one of the head of the fabled Medusa.

Prof. Leidy then directed attention to several other specimens which had been sent to him for information. One of these is a bunch of tapeworms, 15 individuals of *Tænia diminuta*, from the intestine of a rat. The other is the liver of a rat, with a multitude of cysts, the size of large peas, containing *Cysticercus fasciolaris*. In a letter, accompanying the specimens, Dr. John R. Hewett states, that last spring he had examined about 500 rats (*Mus decumanus*), in Carroll Co., Mo., and only in half a dozen instances did he find the liver free from the parasite.

Messrs. Geo. A. Binder, Jacob Binder, Charles Henry Hart, and H. Dumont Wagner were elected members.

The following papers were ordered to be printed:—

NOTE ON HYRACEUM.

BY WM. H. GREENE, M.D., AND A. J. PARKER, M.D.

Among the native remedies from the Cape of Good Hope, exhibited at the Centennial Exhibition, was a peculiar substance called hyraceum, which was supposed to be the inspissated urine of the Cape Hyrax (*Hyrax capensis*).

The material was obtained from Dr. Leidy, who, in the Proceedings of the Academy, December, 1876, p. 325, gave a short account of it. According to this account, "the Hyrax is reputed to inhabit gregariously rocky places at the Cape of Good Hope, and the accumulated urine in the hollows of rocks, gradually evaporating, is supposed to give rise to the product in question. It is reported as having been employed in medicine with the same effect as castoreum."

Prof. Cope remarked that "a material resembling the concretion made by the urine of the Hyrax was found in the fissures of the rocks of New Mexico. It is probably the fecal and renal deposit of the wild rat, *Neotoma*."

About two years ago, we made an exhaustive examination of this substance. It is a dark-brown, brittle, and resinous material, having an aromatic odor, and a bitter taste. About 56 per cent. of it is soluble in water, and nearly one-third of the residue from the aqueous extraction is soluble in alcohol, ether, and chloroform.

The soluble material amounts in all to about 70 per cent., and the remainder is composed of 14 per cent. of woody fibre and

sufficient quantity for separation, and an ultimate organic analysis. It gives out a fecal odor, and seems to be derived from fecal matter.

The analysis, the details of which are subjoined, shows that the substance is a mixture of various salts and organic matter, the latter constituting about one-half, and containing traces of urea, together with uric, hippuric, and benzoic acids. We also obtained from the material a small quantity of a substance having a sweet taste, and which is probably glyocol(?) derived from the breaking up of hippuric into benzoic acid, and this substance.

Hyraceum is undoubtedly derived from the urine of some animal, but the large amount of lime (6 per cent.) in proportion to the other salts, and the character of the organic matter contained, indicates that it also contains fecal matter.

Analysis of Hyraceum.—Water, by dessication, 7 per cent.

A microscopical examination revealed nothing of importance. Woolly fibres, particles of sand, and a general granular appearance were found.

DRIED MATERIAL.

Ash	84.15
Organic substances soluble in water	87.44
" " " alcohol, ether, and chloroform	14.54
Woolly fibre, and insoluble organic substances; residue	13.87
	<hr/>
	100.00

Ash.

Soluble in water	10.20
Insoluble "	14.95
	<hr/>
Potassa	2.95
Soda	8.95
Lime	6.00
Magnesia	2.10
Iron . . . . .	.12
Sand	2.00
Sulphuric acid . . . . .	.60
Carbonic "	3.64
Phosphoric acid . . . . .	.97
Chlorine	6.45
Traces of nitric acid, and loss . . . . .	.37
	<hr/>
	31.15

**MORPHOLOGICAL NOTES ON THE LIMBS OF THE AMPHIUMIDE, AS
INDICATING A POSSIBLE SYNONYMY OF THE SUPPOSED GENERA.**

BY JOHN A. RYDER.

Little attention has apparently been given to the comparative history of the limbs of the known species of *Amphiuma*. Very young specimens do not seem to have been usually collected for museums. I have had the opportunity to study such a series varying from 6 to 8 inches long, and about $\frac{1}{4}$ th inch, or a little more, in diameter; they were obtained in the vicinity of Biloxi, Mississippi, and are the property of the Smithsonian Institution at Washington.

From these it appears that the digital elements of the limbs are variable, or liable to variation in the same individual, so that in some the number of digits (two) is characteristic of *Amphiuma*, and in others (three) they are characteristic of *Muraenopsis*. This blending of the characters of the two genera may be illustrated as follows, indicating the number of digits on each limb by numerals, arranged in fours, the first pair representing the digital formula of the four limbs, thus: (1) $\frac{2}{3} \frac{2}{3}$; (2) $\frac{2}{3} \frac{3}{3}$; (3) $\frac{3}{3} \frac{3}{3}$; and (4) $\frac{2}{3} \frac{3}{3}$; there was also a form which exhibited no outward indication of toes on the front pair of limbs, the digits being inclosed in a common investing integument; this fifth form may be represented in this manner $\frac{\{2\} \{3\}}{\{2\} \{3\}}$. It is plain from the foregoing, that at no very

tions very uncommon, as he has never in his experience met with any instance in which there was as much variation in the number of digits as exhibited in these Biloxi specimens. They can hardly, however, be regarded as monstrosities, as the percentage of varying specimens in this series is entirely too high. I am inclined to believe that they are simply instances on the one hand of reversion toward a still older, and more unspecialized type, and on the other of a tendency to become specialized or reduced, as in the case where the two digits are covered by a common tegumental investment. If the distribution of species will in any case serve to throw light upon the differentiation of genera, I think that in this instance we may assume, with much show of reason, that the individuals most remote from the centre of maximum development of species and individuals exhibit the greatest tendency towards digital reduction. The most northern form, *Amphiuma*, seems to be constantly didactyle, whilst the more southern forms are both di- and tridactyle, which would seem to indicate that the forms most remote from the centre of distribution have been under conditions tending to produce didactylism synchronously with di- and tridactylism at the centre aforementioned. This, however, is only a hypothetical view of the case.

The admission of *Muraenopsis* and *Amphiuma* to generic rank on account of a difference, which is here shown not to be constant, is doubtful. The digits, which from the fact of their having undergone reduction, seem to be not so much rudiments as vestiges of former digits, render the legitimacy of the distinction even more open to question. For I think it cannot be doubted that such a tendency to degenerate, accompanied with a consequent tendency to produce synthetic characters, shows clearly that nature has not yet concluded that they shall be genera, notwithstanding the dicta and definitions of systematists.

ON THE LAND SHELLS OF THE MEXICAN ISLAND OF GUADELUPE,
COLLECTED BY DR. E. PALMER.

BY W. G. BINNEY.

The island of Guadelupe is about 220 miles from San Diego, off the west coast of Lower California. Its molluscan fauna has for the first time been made known by the researches of Dr. Edward Palmer, who visited it in 1875. He found numerous fragments of snail shells which had been devoured by a species of mouse, the only inhabitant of the island. These fragments appear to belong to *Arionta Rowelli*, Newcomb (see L. & F. W. Sh. of N. A. I. p. 185), a species found in Lower California. Some perfect shells were found, among them a smaller variety. *Arionta facta*, Newcomb, was also found, the variety with open umbilicus, like that form found fossil on San Nicolas Island, California.

The most interesting discovery, however, is that of living specimens of *Binneya notabilis*, a species found also on the California island of Santa Barbara. There is strong reason for believing the Mexican genus *Xanthonyx* to be synonymous with *Binneya*. We may suppose, therefore, that from Mexico the genus has been introduced by the usual means of distribution to this island of Guadelupe, and thence to Santa Barbara. Thus, its presence on the latter island is accounted for, which was not the case when we had only the mainland of California to look to, as its absence there has been proved. So, also, in the case of *Arionta facta*, we

LIST OF LAND SHELLS INHABITING RURUTU, ONE OF THE AUSTRAL ISLANDS, WITH REMARKS ON THEIR SYNONYMY, GEOGRAPHICAL RANGE, AND DESCRIPTIONS OF NEW SPECIES.

BY ANDREW GARRETT.

The small island of Rurutu = Oheatora of Capt. Cook, lies in south lat. $22^{\circ} 34'$, and west lon. $150^{\circ} 13'$, which is about 320 miles S. S. W. from Tahiti. As near as I can ascertain it is about eight miles in length, and has an elevation of about 1500 feet, over 100 feet of which consists of ancient coral reefs, which have been upheaved to that altitude.

Mr. Hugh Cuming was the first who visited the island for the purpose of collecting shells, and discovered two or three new species. The next experienced collector, Mr. Charles De Gage, who resides there, gathered a number of land shells, which he kindly forwarded to me for identification, and which form the subject of this paper.

***Microcystis subtilis*, Anton.**

Helix subtilis, Anton, Verz. p. 83; Pfeiffer, Mon. Hel. vol. II. p. 38;

Reeve, Conch. Icon pl. 111, fig. 626.

Helix citrinella, Pfeiffer, Symb. vol. II. p. 41.

Helicopsis citrinella, Beck, Ind. p. 20.

Nanina (*Microcystis*) *subtilis*, Albert, p. 60.

Oheatora = Rurutu (Cuming).

This species was not found by De Gage.

***Microcystis punctifera*, sp. nov.**

Shell small, imperforate, orbicular, depressed, thin, smooth, shining, transparent, light-brownish horn color, dotted with white; spire convex; suture linear; whorls $4\frac{1}{2}$, depressly convex, radiately striate beneath the suture, moderately and regularly increasing; the last not descending in front, rounded on the periphery; base indented; aperture sub-vertical, orbicular lunate, wider than deep; peristome straight, simple, margins remote; columella slightly thickened with callus.

Height 3, major diameter $4\frac{1}{2}$ mill.

It is smaller, and darker colored than *subtilis*, which latter is pale horn color, and six mill. in diameter. It is more like *M. brunnea* collected by Cuming at Pitcairn's Island, which is about the same color, with white dots, but like *subtilis* is six mill. in diameter.

Patula Rarutensis, sp. nov.

Shell umbilicate, discoid, thin, translucent, yellowish-horn color, the spire tessellated, and the last whorl with radiating flexuous fuscous stripes; radiately ribbed with small thin flexuous costæ, and decussated with microscopical raised lines; spire depressly convex; suture sub-canalicate; whorls 5, convex, narrow, slightly turgid near the suture; slowly and regularly increasing, the last not descending in front, sub-angular on the periphery; umbilicus deep, about one-fourth the major diameter of the shell; aperture somewhat oblique, depressly lunate; parietal region with a small revolving lamina on the upper third of the wall; peristome acute, straight, with remote margins.

Major diameter $3\frac{1}{2}$, height 2 mill.

The fine spiral striæ, thin ribs, single parietal lamina, and depressed sub-angular body whorl are its most prominent characters, and will readily distinguish it from any of the south Polynesian species.

Pitys De Gagei, sp. nov.

Shell umbilicate, sub-discoid, thin, translucent, corneous or luteous, horn color, spire more or less distinctly tessellated with chestnut-brown, and the last whorl radiately strigate with the same hue, the stripes sometimes flexuous, and the base either unicolor or adorned with stripes; sculpture consisting of fine, closely-set, radiating, slightly arcuate, thin, costulate striæ, smaller and more crowded beneath; spire convex, apex planulate; suture canalicate; whorls 6, convex, narrow, swollen next the suture, slowly and regularly increasing, the last not deflected in front, slightly depressed, and

Judging from the number sent this is an abundant species. A few years ago I received a large quantity from Tubuai, also one of the Austral group, and nearly 100 miles east of Rurutu. That group is, without doubt, its specific centre, or metropolis.

The most surprising feature in the geographical distribution of this species is its occurrence in three distinct groups of islands. It is found, though sparingly, in nearly every valley in Tahiti, which is over 800 miles from its metropolis. I also obtained it at Mangaia, one of the Cook's or Hervey Islands, 400 miles west of Rurutu.

Had it only been detected in one or two valleys in Tahiti, its introduction could have been attributed to human agency. But when we consider its wide diffusion we can only account for its presence either by a separate creation of the same species in three groups of islands, or speculate on its distribution in some remote period, when the three groups formed a single large island, or part of a continent.

After a careful comparison of many examples from the three groups of islands, I cannot detect the slightest variation. Shells from the same locality vary slightly in the length of the spire, in size and thickness.

It is a strictly arboreal species, and may be distinguished by its uniform white color, flat, and widely-expanded peristome, and gibbous columella lip.

Reeve's figure is too much elongated.

***Stenogyra juncea*, Gould.**

Bulimus juncea, Gould, Proc. Bost. Soc. 1846, p. 191; Ex. Shells, p. 76, fig. 87—Pfeiffer, Mon. Hel. vol. II. p. 220.

Stenogyra upolensis, Mousson, Jour. d. Conch. 1865, p. 175.

Bulimus upolensis, Pfeiffer, Mon. Hel. vol. VI. p. 100.

This common species is very widely diffused through Polynesia. I have found it inhabiting all the groups north of the equator, and south at all the islands from the Marquesas and Paumotu to the Viti group, and, in all probability, it ranges further west.

They are found under loose stones, beneath decayed wood, and among dead leaves, and range from near the seashore to 2000 or more feet above sea-level. The animal is light yellow.

***Vertigo pediculus*, Shuttleworth.**

Pupa pediculus, Shutt., Bern. Mitth. 1852, p. 206—Pfeiffer, Mon. Hel. vol. III. p. 537—Mousson (Var. *Samoenais*), Jour. de Conch. 1865, p. 175.

Vertigo pediculus, Pfeiffer, Vers. p. 177.

Pupa sphyradium (Samoensis), Paetal, Cat. Conch. Sam. p. 106.

Pupa nitens, Pease, Proc. Zool. Soc. 1860, p. 459—Pfeiffer, Mon. Hel. vol. VI. p. 329.

Pupa hyalina, Zelebor, Pfeiffer, Mon. Hel. vol. VI. p. 329.

? *Vertigo nacca*, Gould, Proc. Bost. Soc. 1862, p. 280.

The few specimens received differ none from Tahitian and Cook's Islands examples.

At the latter location I found them in vast numbers on stony ground in a grove near the seashore, but comparatively rare in the mountain ravines. It occurs in more or less abundance at all the Polynesian Islands, also at the Viti group, and perhaps extends further west.

I obtained Mr. Pease's type specimens of *nitens* at Ebon, a low coral island in the Caroline or Marshall group. When he described that species he was not aware that Mr. Shuttleworth had anticipated him in his *pediculus*, described from Tahitian and Marquesian examples.

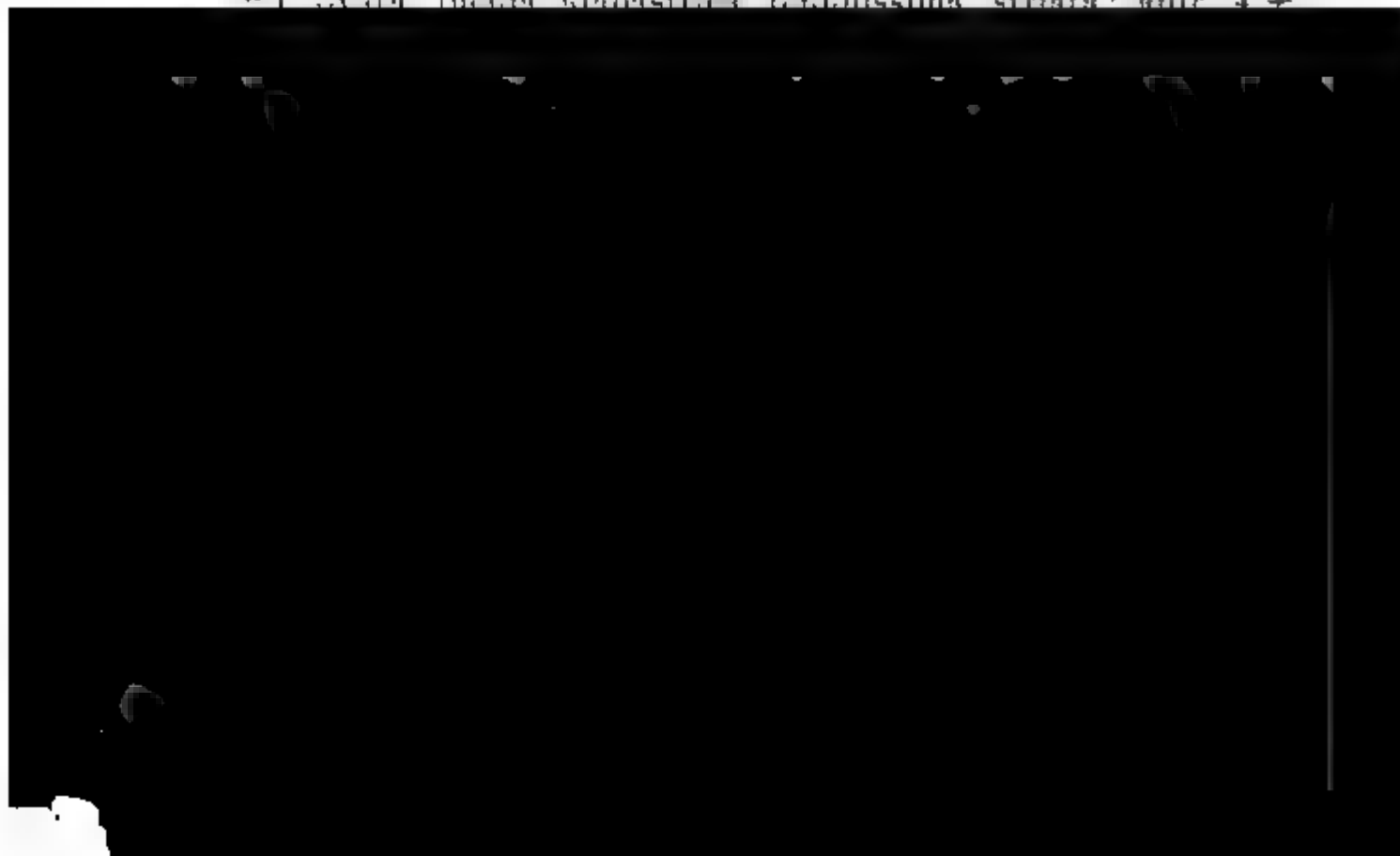
It is evident from Mr. Pease's remarks on page 463, Proceedings of the Zoological Society for 1871, that he entertained doubts of the specific weight of his *nitens* and Gould's *nacca*.

Many years ago I collected a species of *Vertigo* near Hilo, Hawaii, where Dr. Gould's types were obtained, and as near as I can recollect they differed none from *pediculus*.

The description of *nacca* is so brief and unsatisfactory that I cannot decide with certainty, so have marked it doubtful.

The following is Gould's diagnosis:—

"*Trochus* lucida, alabastrina, tenuissima, striata: anfr. 4 +



absent. Sometimes they are duplicated, or double, and more rarely may be seen rudimentary or secondary denticles besides the normal number.

***Tornatellina oblonga*, Pease.**

Tornatellina oblonga, Pease, Proc. Zool. Soc. 1864, p. 673—Pfeiffer, Mon. Hel. vol. VI. p. 264.

Tornatellina bacillaris, Mousson, Jour. de Conch. 1871, p. 16, pl. 8, fig. 3.

A common species, ranging from the Marquesas and Paumotu to the Samoa Islands, and perhaps extends further west to the Viti group.

Prof. Mousson gives an accurate description of *oblonga* under the name *bacillaris*, from Samoa examples collected by Dr. Graffe.

They are found among dead wood and leaves, and sometimes on the fronds of ferns. They range from near the seashore to 2000 or more feet above sea-level.

Mr. Pease's type specimens were collected at the Society Islands.

***Tornatellina conica*, Mousson.**

Tornatellina conica, Mousson, Jour. de Conch. 1869, p. 842, pl. 14, fig. 8; l. c. 1870, p. 128; l. c. 1871 (Var. *impressa*), p. 16.

Cionella (*Leptinaria*) *conica*, Paetel, Cat. Conch. Sam. p. 106.

Tornatellina oblonga, Pease (Part), Proc. Zool. Soc. 1864, p. 673.

This species, which is not uncommon, ranges from the Marquesas to the Viti Islands, and was collected by Dr. Graffe on the low coral islands of Ellice's group in central Polynesia.

Mr. Pease received from me some of these shells intermixed with *oblonga*, and supposing the two to be identical he included them in his diagnosis of that species. Since then I have collected thousands of specimens of both species at the various groups; and have hundreds now before me of all ages, and do not hesitate to pronounce them quite distinct. The shell under consideration I refer to Mousson's *conica*. His variety *impressa* is not uncommon in S. E. Polynesia.

As compared with *oblonga*, it is lighter colored, more robust, the spire more tapering, body whorl larger, and frequently with a marked depression in the middle, which is sometimes slightly concave. The parietal lamina is larger, and the columella more tortuous.

Tornatellina Philippi Pfeiffer.

Tornatellina Philippi, Pfeiffer, Zeitsch. Malak. 1849, p. 93; Mon. Hel. vol. III. p. 524.

Pupa Philippi, Kuster, pl. 18, fig. 20, 21.

Leptinaria Philippi, Ad., Gen. Mon. p. 141.

Achatina Philippi (Leptinaria), Pfr., Vera. p. 150.

There were several examples of this species among Mr. De Gage's shells, which differed none from Tahitian specimens. It also occurs at the Cook's and Marquesas Islands, though not common at any of the above-mentioned locations.

It may be readily distinguished by its swollen whorls, globose body, large compressed parietal lamina, and somewhat tortuous columella, which in young examples is biplicate.

Tornatellina simplex, Pease.

Tornatellina simplex, Pease, Proc. Zool. Soc. 1864, p. 673—Pfeiffer, Mon. Hel. vol. VI. p. 266.

Not uncommon at Rurutu, and we found it at the Marquesas, Society, and very abundant at the Cook's Islands.

It agrees precisely with Mr. Pease's description of *simplex*, except having one more whorl, and *all* have the usual, though smaller parietal lamina, which he must either have overlooked or omitted to mention. I collected his type specimens at Tahaa, one of the Society Islands, and am positive this is the shell I sent him. At least I do not know of any species without the parietal lamina. Moreover, this is the only umbilicated species he received from me.

Tornatellina nitida, Pease.

times slightly flattened near the peristome; aperture oblique, oblong, in adults about a third the length of the shell; parietal region with a thin, prominent lamina, which runs nearly parallel with the suture; peristome straight, acute, with the margins remote; columella tortuous, the lower margin armed with a thin, acute, slightly oblique fold; the palate frequently with one or two spiral rows of small compressed denticles.

Length 3, major diameter $1\frac{1}{2}$ mill.

A thin transparent species, with a more tapering spire than *oblonga*, with the twisted columella of *conica*, but readily distinguished from either by the acute plication in the columella, which can only be distinctly seen when looking obliquely into the aperture. Owing to the transparency of the shell, the sutural line appears to be narrowly margined. The palatal denticles, though sometimes wanting, were overlooked by Mr. Pease.

It is worthy of remark that the above author in his list of *Pau-motus* shells received from me, and published in the French Journal of Conchology for 1871, refers the S. E. Polynesia species to his *nitida*.

***Ternatellina affinis*, sp. nov.**

Shell small, imperforate, ovate-conic, thin, smooth, shining, transparent, light brownish-horn color; spire oblong-conic, with planulate outlines; apex obtusely rounded; suture narrowly margined; whorls six, plano-convex, slowly and regularly increasing, the last not deflected in front, rather large; aperture oblique, irregularly abbreviate ovate, a little more than a third the length of the shell; parietal wall with a strongly compressed prominent lamina; peristome acute, straight, regularly curved, margins remote; columella tortuous, not plicate or dentate.

Length $2\frac{1}{2}$, major diameter $1\frac{1}{2}$ mill.

This species, which we have ventured to record as new, is shaped very much like *Philippi*, but the whorls of the spire are flattened, and the body is not so turgid as in that species. The columella has the peculiar twist of *conica*, but our shell is smoother, more shining, the spire more tapering, and the whorls much more depressed.

***Ternatellina micans*, sp. nov.**

Shell small, imperforate, ovate-conic, transparent, thin, polished, faintly striate under the lens, pale brownish-horn color; spire sub-

acute, oblong-conic, sides planulate; suture distinctly and narrowly marginate; whorls six, sub-planulate, slowly and regularly increasing, the last rather large, not descending in front; aperture oblique, ovate-lunate, more than a third the length of the shell; parietal wall with a prominent, strongly-compressed lamina; peristome thin, simple, regularly curved; columella slightly twisted, depressed, armed with a sub-median, nearly horizontal, acute tooth-like fold; palate with numerous irregularly disposed denticles.

Length $2\frac{1}{2}$, major diameter $1\frac{1}{2}$ mill.

The single example before me differs so much from any other species, that, after some hesitation, I have concluded to describe it as new.

It is shaped almost precisely like *affinis*, but has the palatal denticles, and acute, columellar, tooth-like plait of *nitida*.

Tornatellina perplexa, sp. nov.

Tornatellina bilamellata, Schmeltz (not Anton), Cat. Mus. Godeff. No. 5, p. 90.

Shell small, oblong-conic, imperforate, fragile, glossy, pellucid, smooth, pale brownish-horn color; spire oblong-conic, with sub-planulate outlines; apex obtusely rounded; suture distinctly linear; whorls six, convex, moderately and regularly increasing, the last convexly rounded, not deflected in front; aperture oblique, ovate-lunate, about one third the length of the shell; peristome thin, straight, regularly curved; columella depressed, tortuous, bi-dentate, the basal tooth small, the upper, which is sub-median, is large and prominent; parietal region with a large, prominent, curved lamina; palate furnished with more or less

have the internal teeth so distinct as to give the aperture a ringed appearance.

Cook's Island examples sent to the Museum Godeffroyanum were erroneously referred to Anton's *bilamellata*, a species twice the size of this.

***Tornatellina serrata*, Pease.**

Lamellina serrata, Pease, Proc. Zool. Soc. 1860, p. 439.

Tornatellina serrata, Pfeiffer, Mon. Hel. vol. VI. p. 265.

Lamellina lavis, Pease, Proc. Zool. Soc. 1864, p. 672.

Tornatellina lavis, Pfeiffer, Mon. Hel. vol. VI. p. 266.

This species has the same extensive range through Polynesia as *nitida*. Many years ago I found the same, or a closely allied species on low bushes near the seashore at Guam.

They, like nearly all the species, are usually found adhering to the under surface of loose stones, dead wood, among decayed leaves, and sometimes on the leaves of low bushes.

I obtained Mr. Pease's type examples of *serrata* at Ebon, in Micronesia; and his *lavis* at Huahine and Tahiti. Mr. Cuming, who received specimens of both species, considered them identical.

After a careful examination of a large number of all ages from the different groups of islands, I find the palatal lamina much more frequently serrated than smooth. They are, in fact, all smooth at certain periods of their growth.

The description of *serrata* is somewhat obscure; that of *lavis* is more accurate.

It cannot well be confounded with any other Polynesian species; its ovate-conic form, swollen whorls, deep suture, acute columellar tooth, and, more particularly, the remote longitudinal, prominent, smooth, or serrated palatal laminae will readily distinguish it from any other.

The last character induced Mr. Pease to establish his genus *Lamellina*. In his list of Polynesian land shells published in the Proceedings of the Zoological Society for 1871, he records only two species, his *serrata* and *lavis*, while he overlooked the same, but less conspicuous character in *Hudalga*, Crosse, inhabiting the Gambier Islands. The accurate figure of that species in the Journal de Conchyliologie for 1865, exhibits a small bidentate lamina. Specimens from the same locality, now before me, either possess the same feature, or have simply from one to two spiral rows of denticles in the palate.

Petit's *globosa*, from Rapa or Opars is described as having two obsolete plicæ in the palate. In *micans*, *perplexa*, and *nitida* we find short plicæ or denticles, and frequently rudimentary longitudinal lamina. Some specimens of *nitida* have the latter character as strongly developed as in *serrata*. Prof. Mousson has described a Viti species under the name of *columellaris*, which is either the same or very closely allied to *nitida*, and possesses denticles in the palate.

If the genus *Lamellina* is accepted, it should be modified so as to include all the species with either denticles, plicæ, or laminae in the palate, though the character on which the genus is based is not, in my opinion, of sufficient importance to rank as generic.

There are several other species described, from other parts of the world, which possess the same characters.

Succinea De Gagei, sp. nov.

Shell ovate, pale to dark-amber color, or ferruginous, thin, fragile, pellucid, scarcely shining. more or less rugose with lines of growth; spire moderately produced, sub-acute, less than a third the length of the shell; whorls 3-3½, convexly rounded, the last large, obliquely produced; aperture sub-vertical, large, regularly ovate, acute above, sides nearly equally curved, rounded below; columella thin, gently arched; peristome acute, regularly curved.

Length 11, major diameter 7 mill.

Mr. De Gage sent about 100 examples of all ages: it is the first species recorded from the Austral Islands.

It is closely allied to Gould's *pudorina*, a Tahitian species, but

and they are common to all the islands. Of these, *striata*, as far as known, has not been discovered elsewhere; while of the remaining four species, *luteus* and *fasciatus* are very widely diffused through Polynesia, Melanesia, and the Indian Seas. *M. Philippi* seems to be confined to southeastern Polynesia. All the above-mentioned four species are correctly determined. We now have only the species under consideration to identify.

In 1871, Mr. Pease published in the French Journal of Conchology a list of Anna (Paumotu Isl.) land shells, collected by me in 1865, and recorded this species as *caffer*, Küst. Adopting his view I distributed the shells to my correspondents, under that name.

The same year he published his list of Polynesian land shells in the Proceedings of the Zoological Society, and excluded *caffer*, but recorded *violus* from Borabora.

Dr. Pfeiffer's *caffer*, var. 3, which Mr. Cuming collected at Rurutu, is undoubtedly the same as our shell.

It is a very common species, and is confined to the Paumotu, Society, and the Austral Islands. Its limited range also proves its distinctness from *caffer*, which is recorded as a south African and Philippine species.

In shape, it resembles *fasciata*, and the last whorl is subangulate above. The spire is convexly conoid, mucronate, and nearly one third the length of the shell; the upper whorls usually have a few faint radiating incised lines. The well impressed suture is more or less lacerated by large wrinkles of growth on the last whorl. The base is sub-rotate, and sometimes decussated with a few faintly-defined impressed striae. Parietal region with two, sometimes three plicae on the basal half, and the brownish-violet columella has a rather small oblique fold. The inner margin of the peristome is always deep chestnut-brown, approaching black, and the palate has 4-6 bluish-white plicae.

Living shells are uniform fuscous; frequently the belly or front of the last whorl is brownish-yellow, with a transverse fuscous band just beneath the middle. Sometimes, though more frequently in immature examples, the ground-color is brownish-yellow, with the spire and upper portion of the last whorl, together with a sub-basal band, fuscous.

Length 12, major diameter 7 mill.

Melampus luteus, Quoy et Gaimard.

Auricula lutea, Q. et G., Voy. Astrol. vol. II. p. 168, pl. 18, fig. 25-27.

Melampus luteus, Pfeiffer, Mon. Auric. p. 86.

Conovulus luteus, Anton., Verz. p. 48.

This species is abundant at all the Polynesian Islands, except the Sandwich and Marquesas groups.

The only variation is in size, and depth of color; it is never banded. This, and the preceding species, are found just above high-water mark.

Omphalotropis curta, sp. nov.

Shell small, rimate, abbreviately ovate, solid, faintly striate, cinereous under a thin yellowish-olive epidermis; spire obtuse, short, convexly-conical, more or less decorticated; suture deeply impressed; whorls five, convex, the last very large, rounded, nearly half the length of the shell, the periphery with a stout rounded keel; basal carination large; aperture nearly vertical, roundly-ovate, whitish or reddish yellow; peristome rather thick, straight, and continuous.

Length 5, major diameter 3½ mill.

Quite distinct from any other Polynesian species, and may be readily distinguished by its short stout shape, and large rounded keel.

Chondrella striata, Pease.

Chondrella striata, Pease, Proc. Zool. Soc. 1871, p. 477.

Hydrocena striata, Schmelz, Cat. Mus. Godeff. No. 5, p. 100.

Mr. De Gage sent several examples of this species, which dif-

striata. *Cyclotoma exigua*, Homb., also from the Gambiers, probably belongs to the same genus.

Mr. Pease, in his description of the genus, remarks, from observations made by me that the animal was destitute of tentacles. Since the above was published, I have verified my former observations by a careful study of many examples of both *striata* and *parva*.

The animal is translucent, and, excepting the large conspicuous black eyes, is colorless in both species. The foot is small, oblong, rounded behind, and during locomotion is nearly or quite concealed by the shell, which is carried diagonally. The head, which is entirely destitute of tentacles, is produced into a short blunt muzzle, which sometimes assumes a slightly bi-lobed appearance. When creeping, only the extreme tip of the muzzle is seen from above, while the conspicuous eyes are plainly visible through the transparent shell.

***Helicina minuta*, Sowerby.**

Helicina minuta, Sowerby, Proc. Zool. Soc. 1842, p. 7; Thes. p. 13, pl. 1, fig. 40-41.

This small species is very abundant, and agrees in every respect with Tahiti and Moorea examples. It is not found on any of the other islands of the Society group, though several species inhabiting the other islands are usually confounded with *minuta*, one of which is described by Dr. Pfeiffer under that name.

Sowerby's type specimens were collected at Rurutu by Mr. Cuming. His diagnosis, though very brief, accords well with the shells before me. The size he gives is also precisely the same. The shell described by Pfeiffer, which is larger, is, as near as I can determine, one of Mr. Pease's unpublished species, which inhabits Raiatea.

***Assiminea nitida*, Pease.**

Hydrocena nitida, Pease, Proc. Zool. Soc. 1864, p. 674.

Hydrocena parvula, Mousson, Jour. de Conch. 1865, p. 184.

Assiminea nitida, Pease, Jour. de Conch. 1869, p. 165, pl. 8, fig. 11.

Assiminea lucida, Pease, Jour. de Conch. 1869, p. 166, pl. 8, fig. 10.

Omphalotropis parvula, Paetel, Cat. Conch. Sam. p. 124.

Hydrocena similis, Baird, Brenchly's Cruise of the Curacoa.

This small species ranges from the Marquesas and Paamotu to the Viti Islands.

They are found under dead wood, among decayed leaves, and range from near the seashore to about 2000 feet above sea-level.

The only variation is in size, more or less produced spire, and color, which varies from a light to dark corneous, rarely brownish, with faint indication of a band on the body whorl.

I obtained Mr. Pease's type specimens of *lucida* in beach sand at Anaa, one of the Paumotu Islands. They were worn, and discolored by salt water. Living shells, which I subsequently found at the same locality, differed none from *nitida*.

DESCRIPTION OF A NEW SPECIES OF GONIOBRANCHUS.

BY ANDREW GARRETT.

***Goniobranchus albopunctatus*, Garr.**

Animal elongate-oval, depressed, the two ends equally rounded, a little the widest at the middle, and, when in motion, it becomes more elongate, and the sides nearly parallel. The dorsal region is depressly convex, smooth, and the margins of mantle thin. The upper surface is bright orange-yellow, with crowded opaque white dots, and minute annulæ; the mantle with a band of small irregular lemon-yellow spots near the margin, which latter is edged with violaceous.

The dorsal tentacles, which issue from simple orifices, are elongate ovate, sub-mucronate, somewhat trigonal, purple-brown, profusely dotted with opaque white, and marked with two vertical lines of the latter color.

The branchial plumes are rather large, twelve in number, connate at their base, decreasing in size posteriorly, and encircling the prominent anal tube; they are colored and dotted similar to the tentacles, and each ornamented with two longitudinal white lines.

The under surface of the mantle and foot are pale lemon-yellow, the former margined the same as above.

The head is small, and furnished with moderate, obtuse, cylindrical tapering labial appendages.

The foot is elongate, narrow, obtusely rounded in front, sides parallel, rounded behind, and, when in motion, extends considerably behind the mantle.

Length, 62; diameter, 20 millimetres.

Hab.—Huahine, Society Islands.

A very rare species found on weedy bottom in the upper region of the laminarian zone, and is the only example which has occurred to my notice during ten years collecting in the group.

FEBRUARY 4.

The President, Dr. RUSCHENBERGER, in the chair.

One hundred and nine persons present.

Fossil Remains of a Caribou.—Prof. LEIDY directed attention to several fossil specimens which he had received for determination from Prof. F. M. Witter, of Muscatine, Iowa. They were found together, with others apparently of the same animal, in the Loess on which the city of Muscatine is built.

Two of the fossils consist of fragments of the left side of the upper and lower jaws, retaining most of the molar teeth in good condition. Another specimen is an uncharacteristic bone fragment. Other bones were too much decomposed for preservation.

The specimens with teeth indicate a species of deer, of an individual past maturity, as the crowns of the teeth are half worn away, exhibiting broad, comparatively flat surfaces. The character of the fossils appeared unfamiliar, and at first were suspected to have pertained to an extinct and undescribed species. The proportionately large size of the premolars, in comparison with those of ordinary forms of deer, appeared as a distinctive feature.

Observing that the fossils were larger than the corresponding parts of the barren ground caribou, *Rangifer groenlandicus*, it was suspected that they may have pertained to the woodland caribou, *Rangifer caribou*. In this view, not having the latter for comparison, the specimen of the upper jaw with the teeth was sent to Dr. Elliott Coues, of Washington, with the request that he should compare it with specimens of the woodland caribou in the collection of the Smithsonian Institution.

Dr. Coues reports that the fossil was carefully compared with



The fossil remains of the deer, at first supposed to belong to an extinct species, for which the name of *Cervus muscatinensis* was suggested, were discovered in grading a street in the city of Muscatine. From the Loess of the same locality Prof. Witter has collected the following fossil shells: *Helix striatella*, *H. fulva*, *H. pulchella*, *H. lineata*, *Pupa muscorum*, *P. blandi*, *P. simplex*, *Succinea obliqua*, *S. acara*, *Limnea humilis?* and *Helicina occulta*.

FEBRUARY 11.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-one persons present.

Natives of Botel Tobago.—The President read the following extract from a letter by Dr. CHARLES A. SIEGFRIED, U. S. N., dated December 20, 1878: "We visited an island called Botel Tobago, while surveying a rock, 80 miles east of South Cape of Formosa. We found a race of aborigines, probably from Malay stock. They knew nothing of money, rum, or tobacco. They gave us goats and pigs for tin pots and brass buttons, and would hang around us all day in their canoes, waiting for a chance to dive for something thrown overboard. They wore cloths only; ate taro and yams mainly, though they have pigs, goats, chickens, and fish, and cocoanuts also. Snakes abound, of the boa variety I judge. Their thatch houses are low, with much overhang of the roof, surrounded by stone walls, strongly made of laid stone to protect them from monsoons. Their paddy fields contain immense quantities of taro, *Colocasia aroides* my botany says. They are peaceful and timid, do not mark the body or deform the face or teeth, and seem happy enough in their condition. I found them fairly healthy. They had axes, spears, and knives, but all of common iron, the axe being made by imbedding the handle instead of the handle piercing the iron, as with us. Their canoes are beautiful, made without nails, and are ornamented usually with geometrical lines. The hair is worn naturally, the men partly clipping theirs. I saw no valuable metal. They wore the beards of goats, with small shells, as neck ornaments."

Cutting or Parasol Ant, Atta ferrens, Say.—The Rev. H. C. McCook stated that he had in course of preparation a detailed account of the architecture and habits of the Cutting Ant of Texas. The observations, of which he proceeded to give an abstract, were made during an encampment for purposes of study, south of Austin, Texas.

1. *Exterior Architecture.*—Two forms were noted. The first, seen at a point distinguished as Camp Wright, was that of a

mound, 21 feet long, and about 4 feet high, which had been accumulated around the trunk of a double live-oak tree, *Quercus virens*, which stood on the side of a road. The second form was located at a point distinguished as Camp Jeanes. It was on a high, flat, upland prairie, and was a bed of denuded earth, in the midst of the grassy open, 8 feet 9 inches long, and 7 feet, more or less, across. Over this denuded surface were scattered between twenty and thirty circular, semicircular, and S-shaped elevations of fresh earth-pellets. The circular moundlets had the appearance of an American spittoon, the resemblance being stronger by reason of a round open entrance or gallery door in the centre. All had apparently been naturally formed by the gradual accumulation of the pellets of sandy soil, as they were brought out, and dumped upon the circumference of the heap. The moundlets were massed at the base, and gradually sloped off towards the top. They were from 3 to 4 inches high. This "bed" (as the natives call it) was quite free from grass, as was also the mound at Camp Wright. Another nest of the same character was found at Camp Jeanes; this was situated in a grove, but was fully exposed to the sun. A fourth nest was found about a mile distant from this spot, of the same character. This is, therefore, probably the normal form of the external architecture of the formicary, the mound at Camp Wright being probably formed by accumulations around the tree, caused by the bordering road, which restricted the limits of the gates, and so threw the separate moundlets back upon each other.

2. *Gates or Doors*.—His first view of the mound at Camp Wright led him to fear that he had made a mistake, and pitched his camp near an abandoned nest. There was not a sign of life. The mound was covered over with earthen knobs or warts of various sizes, but the action of a recent shower upon the black soil gave the hill the appearance of an old one. Here and there were scattered over the surface small and great leaves of dry leaves.

every exit from the nest. The process is a long, careful, and complicated one, and was studied fully. Towards evening the gates are gradually thrown open, and so remain until morning, when they are gradually closed, the process continuing in some cases until 10½ A. M. The closing is done by carrying into the gallery bits of dry twigs of various lengths, some as long as 1½ inch, dry leaves, and other refuse. A number of closed gates were opened to note the depth to which this refuse was placed. It varied from one half inch to an inch and a half from the surface. In some cases the gallery had been sealed up with sand pellets *before* the refuse. The galleries quite often slant inward from the gate, and at as great an angle as 45°. They also sometimes deviate a short distance from the surface. These conformations allow more readily the process of closing. In carrying in the refuse the larger forms of the ant are engaged; as the hole gradually closes, only the very smallest appear. The last touches are carefully and delicately made by the minors, who, in small squads, fill in the remaining interstices with minute grains of sand, and finally, the last laborer steals in behind some bit of leaf, and the gate is closed. It then presents to the casual observer the appearance above described of a little heap of dry chips accidentally accumulated upon the mound. The galleries at Camp Jackson were closed in the same manner.

When the gates are opened at dusk, this process is reversed. The minors first appear, depositing from the heap particles of sand. Larger forms follow, carrying away bits of refuse, which they drop a couple of inches more or less from the gate. This is a slow process, and apparently little is accomplished for a long time. But evidently the whole mass of refuse is thus loosened. Then comes the great rush, with soldiers, majors, and minors in the lead, who rush out bearing up before them the rubbish, which comes here and there, and in a few moments is cleared away from the gateway, and spread around the margin of the gate. These chips are evidently gathered together for this purpose, and are among the "treasures" of the ants, being kept near by for this use. The pieces were easily identified as being thus used several days in succession.

The above observation points out at least the use found for the extremely small forms peculiar to this species. At least ten distinct caste forms or sizes were exhibited to the Academy. They vary as follows, the measurements being in sixteenths of an inch, viz. 1, 14, 11, soldier 7, worker major 6; minor 5, and the remaining castes in the proportion, 3½, 3, 2½, 2, 1½, 1. A more careful comparison may possibly reduce this series one or two. But too small, as above, will probably stand.

The gates first opened are the first closed, and those last opened are the last closed.

3. *Leaf cutting Habit.*—The whole process of cutting and car-

rying leaves from trees and shrubs was observed at Camp Wright and at a vegetable garden near Austin. In order better to see the mode of cutting, small tender branches of live-oak were thrust into the mound near the gates. These were soon covered with ants, and as the lantern could thus be used conveniently, the operations of the cutters were completely in view. The cutter grasps the leaf with outspread feet, and makes an incision at the edge by a scissors-like motion of her sickle-shaped toothed mandibles. She gradually revolves, steadily cutting as she turns, so, her mandibles thus describing a circle, or the greater portion thereof. The feet turn with the head. The cut is a clean one quite through the leaf. The cutter will sometimes drop with the excision to the ground, sometimes retire when the section is dropped, sometimes (it is inferred) seize the section and carry it down the tree. A division of labor was apparent. At the foot of one tree was a pile of cut leaves, to which clippings were continually being added by droppings from above. Carriers on the ground took these up, and bore them to the nest. The mode of the cuttings is thus: the piece is seized by the curved mandibles, the head is elevated, the piece is thrown back by a quick motion, seeming to be lodged on its edge within the deep furrow that runs along the entire medial line of the head (except the clypeus), and supported between prominent spines on the edge of this furrow and on the prothorax. The furrow and spines thus appear to serve a very useful end. The cutting and carrying were not done (so far as noted) by the smaller castes. The soldiers rarely engaged in this work, but were seen to precede the excision columns as they moved out and up the tree, and afterwards to return, as though engaged as scouts or pioneers.

The mounted bearers, on their part, (being, I think, the same as the

hery. He had to be very careful thereafter where he deposited the delectable weed. Mr. McCook saw at another plantation an immense column engaged in plundering a granary of wheat, which was being carried away to the nest.

4. *Interior Architecture.*—The use of this leaf material, in part at least, was unfolded when the work of excavation began. Two trenches were made, one ten feet long, five feet deep, and a second at right angles to it, and wide enough to allow free entrance and study. The number of insects that swarmed to the defence of their home is simply amazing. They were, however, not so difficult to manage as sometimes when disturbed at their night work, as the swift use of the spade by the assistants and the general convulsion of their emmet world quite dazed most of them. However, when the speaker himself entered the trench to work with trowel, knife, rule, etc., the ants rallied, and attacked so fiercely that the men were compelled to brush them off. The wound inflicted by them was sharp, but nothing to compare with the severe sting of the agricultural ant. The interior of the formicary may be briefly described as an irregular arrangement of caverns communicating with the surface and with each other by tubular galleries. These caverns or pockets were of various sizes, 2 feet 10 inches long and less, and 12 inches deep and 8 inches high and less. Within these chambers were masses of a very light, delicate leaf-paper wrought into what may properly be called "combs." Some of the masses were in a single hemisphere, filling the central part of the cave, others were arranged in columnar masses 2½ inches high, in contact along the floor. Some of these columns hung, like a rude honey-comb or wasp nest, from roots which interlaced the chamber. The material was in some cases of a gray tint, in others of a leaf-brown. It was all evidently composed of the fibre of leaves which had been reduced to this form within the nest, probably by the joint action of the mandibles and salivary glands. On examination they proved to be composed of cells of various sizes, irregular in shape, but maintaining pretty constantly the hexagon. Some of the cells were one-half inch in diameter, many one-fourth inch, most of them one-eighth inch, and quite minute. Large circular openings ran into the heart of the mass. Some of the cells were one inch deep; they usually narrowed into a funnel-like cylinder. Ants in great number, chiefly of the small castes, were found within these cells. In the first large cave opened were also great numbers of larvae. The material was so fragile that it crumbled under even delicate handling, but a few specimens of parts of the ant comb, with entire cells, were preserved and exhibited. Reference was made to the late Mr. Bell's opinion that these leaf-paper masses were used as a sort of "mushroom garden," a minute fungus being purposely cultivated upon them, which the ants used for food. Mr. McCook's specimens, when submitted to the microscope, did

indeed show the appearance of such growth, which, however, is only what might have been expected under such environment. The belief was expressed that the ants fed upon the juices of the leaves. But (if investigations in progress shall succeed, it was hoped that the subject of the true food of the cutting ant would be hereafter solved.

5. *Tunnelled Tracks*.—The ability of these emmet masons to excavate vast halls and subterranean avenues is remarkable. Several holes in the vicinity of Austin were visited, out of which "beds" or nests of ants had been dug, by an old man who used to follow the business of ant killing. These holes were nearly as large as the cellar for a small house. One such excavation, about three miles from Austin, was 12 feet in diameter and 15 feet deep. At the lowest point had been found the main cavity, quite as large as a flour barrel, in which were found many winged insects, males and females, and quantities of larvæ. This nest was situated 668 feet from a tree that stood in the front yard of a house which the ants had stripped. Mr. McCook took the range of the underground way traversed by the ants to reach this point, from which an accurate route was constructed and exhibited. The course varied very little from a direct line. Two branch tunnels were made to a peach orchard 120 feet distant. Reference was made to a paper by Dr. Lincecum in the Proceedings of the Academy, which gave an account of the tunnelling of a street by these ants. There is nothing improbable in this, as the tunnel above referred to went down in places as deep as 6 feet, the average, however, being about 18 inches. At the exit hole the tunnel was 2 feet from the surface. The digging operations were described, in which the small forms alone seemed to take part. The

the worker-life enwrapped in the egg. But it appears quite impossible to comprehend how any structural modifications could act from the worker upon the queen in order to thus react upon a succeeding generation of workers. The illustrations which Dr. Darwin cites,¹ the variation of domestic cattle by interbreeding, and M. Verlot's experiments with certain double annual flowers, if admitted to throw some light upon the inquiry, yet require an efficient superintending human intelligence, which cannot be supposed to have its analogue in the perpetuation and development of ant forms, unless, indeed, we may believe that the evolution hypothesis implies and requires the interposition of a Personal Intelligence infinitely superior to that of both ant and man.

The precise sense in which the workers may be called "sterile" admits of some question. Sir John Lubbock has recently shown that parthenogenetic eggs are sometimes produced by worker-ants in artificial formicaries, from which males alone are hatched. This is according to the analogy of other Hymenoptera, as for example, bees and wasps. Here, then, there may be possible escape from Dr. Darwin's difficulty more satisfactory than that which he himself suggests; for it is conceivable that an opportunity might thus be opened for the transmission of a profitable variation which might arise in a worker. Still, the difficulty appears impassable. One must suppose the growth and maturity of one such parthenogenetic male, produced from a worker with such useful modification, to have been contemporaneous with the maturity of the females of a "swarm;" this male, together with the males hatched directly from eggs laid by the queen shall have gone forth, as is the habit of ants, in the regular marriage flight, or "swarming;" and therein shall have met a virgin queen. As the modification thus supposed to be transmitted, must, on the hypothesis, be very minute, it could have been saved from obliteration, only by supposing it fortified by the recurrence of other contingencies of like character in succeeding generations. Mr. McCook therefore concluded that the development by natural selection, according to Dr. Darwin's hypothesis, of so many and widely varied forms as exist in the cutting ant, requires a series of contingencies so multiplied and remote as to forbid a reasonable hope of its probable occurrence, even with the additional favoring circumstance of occasional males parthenogenetically produced.

He added that some of the points which Dr. Darwin had raised as to the structure of the driver ant of Africa were being carefully examined by him in the case of *Atta ferrens*, with the best microscopic helps at his command. Thus far, however, after a quite careful examination, nothing that can suggest the idea of an interblending of the castes by rudimentary forms had been discovered. The lowest castes of minors, in all specimens examined, with special reference to the mouth organs and eyes, showed the

¹ Origin of Species, p. 227.

same structure, in equal definiteness and perfection, as the larger castes. Allusion was also made to the ravages of these destructive insects, and some of the modes for exterminating them were explained.

FEBRUARY 18.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty persons present.

A paper entitled "On the Structure of the Chimpanzee," by H. C. Chapman, M. D., was presented for publication.

On Bothriocephalus latus.—Prof. LEIDY exhibited specimens of a tape worm, which had been submitted to him for determination by Dr. John T. Walker. The specimens consist of about a dozen portions of what appear to have been four or five individuals, all of them unfortunately without the head. They were discharged by a man, aged 28 years, formerly a farmer, a native of Sweden, who came to this country about three months since. At irregular intervals during the last five years the patient passed fragments, of a few inches, of the worm. According to Dr. Walker, the collective measurements of the specimens presented he had estimated to be upwards of 100 feet. In their contracted condition, as preserved in alcohol, none of the mature segments measured over 4 mm. in length by 10 mm. in breadth. These are quite characteristic of *Bothriocephalus latus*. The egg pouches of the uterus centrally situated are rendered distinct from the ripe eggs which give to them a chocolate-brown appearance. The genital apertures are in the median line, nearer the anterior border of the segments. In *Trema*, the genital apertures are at the

borhood of Vincenttown. It seems that this peculiar hydrocarbon had not been observed in the State of New Jersey before; at least no mention of it is made in the Geological Reports up to 1868. The specimen presented to the Academy had attached on one side a layer of the marl in which it was found. As the material in question is properly considered a mixture of various hydrocarbons, it seems to be obvious that the properties vary according to the predominance of one or the other substance contained therein. This kind is very brittle, black, with a resinous lustre. Its fracture is uneven, inclined to conchoidal; the streak and powder appear brown. It melts easily in the flame, like wax, and burns with a yellow smoky flame, leaving, after burning, a voluminous coal and but little ashes. In water, alcohol, and solution of caustic potassa, it is not soluble. It dissolves in chloroform and in oil of turpentine. In ether it dissolves with difficulty, forming a yellowish brown solution by transmitted and a dirty greenish solution by reflected light. Oil of vitriol dissolves it into a black liquor, which, when poured into water, shows that a part of the substance is retained in solution, whilst another subsides as a dark colored powder. Nitric acid reacts on the substance at an elevated temperature, forming therewith soluble products of oxidation.

Not far from the pit from which the asphaltum had been obtained, a specimen of yellow mineral resin was found. It occurs frequently in the marl of the cretaceous formation, but not regularly; sometimes hundreds of tons may be looked over without finding a single piece; at other times enough has been found to fill a barrel within a day. It is usually known under the name of amber or succinite.

It differed in several particulars from the typical amber found at the bottom and on the coast of the Baltic Sea. Our specimen is lighter than water, whilst the amber from the Baltic is specifically heavier. The latter fuses into a thick sluggish fluid, the Vincenttown amber into a very fluid mobile liquid; the cohesion of the Baltic product is stronger than in the specimen in question. These differences indicate its analogy to the variety of succinite called Krantzite by C. Bergeman, who reported its occurrence near Nieuberg, Germany.

It melts on heated platinum foil into a brown liquid, which runs like water. It takes fire easily, and burns with a yellowish, strongly smoking flame, leaving but little coal, which rapidly burns away and leaves a small quantity of dark colored ashes as a residue. Heated in a closed tube it melts and vaporizes into a gray cloud, which condenses easily to an oily liquid and some small crystals, which are probably succinic acid. The odor of the fumes is strongly penetrating, like acrolein. In water, alcohol, or ether, it seems to be but sparingly soluble. In chloroform, bisulphide of carbon, and in oil of turpentine, it dissolves freely. Oil of vitriol makes with it a red solution. Cold nitric acid seems

not to affect it much. On warming, the yellowish powder becomes orange-red. It is partly dissolved by caustic potassa. In this yellowish brown Krantzite, Mr. Goldsmith noticed on a fresh fracture a row of white crystals arranged in radiating groups. The crystals were too small for mechanical separation, but the opinion was expressed that they were Succinellite.

The following were ordered to be published:—

DESCRIPTIONS OF THREE NEW SPECIES OF CALCEOLIDÆ FROM THE
UPPER SILURIAN ROCKS OF KENTUCKY.

BY VICTOR W. LYON.

For several years past there have been found in the ferruginous clay and light-gray marly limestone of the Niagara period, which outcrops at the quarries in Jefferson County, Kentucky, on Bear-grass Creek, one mile east of Louisville, many fossils, which have been considered by some collectors to be a species of coral allied to *Zaphrentis*.

Until November 25th, 1877, all the specimens which I found were in such a state of preservation that they could not be determined.

Since my attention has been called particularly to these specimens, I have collected one hundred and seventy well-preserved fossils, which I regard as true *Calceolæ*. There are four distinct species, of which three are new.

In the same bed, associated with these new forms of *Calceola*, are found *Calceola Tennesseensis* (Roemer); *Orthis elegantula*, *O. hybrida*, *O. nisis*, *O. rugæ plicata*; *Spirifer radiata*, *S. crispus*, *S. rostellum*; *Pentamerus nysius*, *P. Littoni*, *P. Knappi*, *P. nucleus*; *Rhynchonella Saffordi*, *R. Tennesseensis*, *R. neglecta*; *Cyrtia eximiosa*; *Caryocrinus ornatus*; *Eucalyptocrinus calatus*, *E. crassus*; *Haplocrinus ovalis*, etc. The new species referred to are as follows:—

Genus **CALCEOLA**, Lamarck, 1801.

Calceola corniculum, V. W. Lyon, n. sp.

Shell thin; valves not articulated; ventral valve horn-shaped; area high and narrow, greatly curved to the left, flat, one inch along the shorter curve, from apex to hinge; hinge straight, four-tenths inch long, at an obtuse angle to the apex.

Draw a line from the centre of the hinge perpendicularly, and it will cut the longer curve of the area midway between apex and hinge.¹

¹ I have before me two very perfect ventral valves of *C. Tennesseensis*, from Decatur County, Tenn., Upper Silurian. Shell triangular pyramidal, area one inch from apex to hinge; hinge line one inch wide.

If a line be drawn from cardinal process to apex, it will divide the shell

Dorsal side of ventral valve sub-semicircular, markings of growth indistinct, parallel to sub-semicircular opening; dorsal side of opening almost perpendicular to hinge line, or about one-tenth inch nearer to the apex.

Cardinal process or tooth central, round and smooth along its summit, three-tenths inch in length, three-tenths in width, gradually narrowing from the hinge backward, extending from the hinge line to the inner end of cavity.

The characters which separate this species from *C. Tennesseeensis*, Roemer, and *C. sandalina*, Lamarck, are well marked. The semicircular margin of the mouth in *C. Tennesseeensis* is one-half inch from the apex; while in *C. corniculum* it is nine-tenths inch, or almost over the hinge line.

Position and Locality.—A few good ventral valves have been obtained from the ferruginous clay, Niagara period, one mile east of Louisville, north side of Beargrass Creek.

Calceola Coxii,¹ V. W. Lyon, n. sp.

Shell thick, triangular, valves not articulated; ventral valve pyramidal; area large, flat, triangular, nine-tenths inch high, with an obscure central line; markings of growth prominent, extending around the shell parallel to hinge; hinge line straight crenulated, four-tenths inch long.

Mouth semicircular; cavity three-tenths inch deep; all around the mouth, extending centrally towards the bottom of cavity, are linear rows of punctures, not so conspicuous as in those of the European species, *C. sandalina*. The cardinal process central, indistinct, short, round, and smooth along its summit.

marly limestone of Niagara period, north side Beargrass Creek, one mile east of Louisville, Jefferson County, Ky.

I have two excellent specimens with both valves united; also ten good ventral valves of this species.

Calceola attenuatus, V. W. Lyon, n. sp.

Shell thick, attenuated, valves not articulated; area of ventral valve high and narrow, curving to the right, then to the left, then to the right (some have three curves, others only two); area straight part of the distance from the aperture toward the apex, then curving gradually upward and outward (some specimens have two curves upward, others one); area two inches high, with an obscure central line; hinge three-tenths inch wide, straight.

Markings of growth in some specimens very prominent, also striae extending around the shell, parallel to the semicircular opening or mouth. One of the most remarkable features of this species is, that along the outer edge, and sometimes the central line of the area, at almost each line of growth, and also in one or two specimens at the mouth of the shell, are one or more processes or small bodies having the appearance of foot-stalks. Some of them are one-tenth inch in length, others four-tenths. At first I thought these processes had served merely to attach the shell to some permanent body; but after cleaning one very large and elegant specimen, I discovered these processes to be young *Calceola*, showing all the distinct features of the older one.

In one young ventral valve, which is attached to the second line of growth of an adult, the cardinal process or tooth is perfect.

Another most singular feature in the adult of this species is, that in two places the central line of the area is lifted at the line of growth, and the cardinal process is seen at each. This specimen has the appearance as if three adults had almost swallowed each other, leaving only the hinge lines and tooth visible. Cardinal process three-tenths inch long, from two to three lines wide, round and smooth along its summit, gradually diminishing in width towards its end, not reaching the end of the cavity. In some specimens the process is larger and longer than above indicated, but it never reaches the bottom of the cavity as in *C. corniculum*. The characters of this species are so well marked that it can be distinguished at a glance from any known species of *Calceola*.

Position and Locality.—I have sixty good ventral valves from the ferruginous clay and marly limestone of the Niagara period, one mile east of Louisville, Ky., north side of Beargrass Creek.

I have no doubt that the young of *C. attenuatus* and of all other species of the *Calceolidæ* became attached immediately after germination, to the inner surface of the rim of the mouth, and remained in this position until they were large enough to support themselves. Lines of growth upon these species are nothing more or less than the margins of former mouths, which are almost always obliterated in very old adults, but in one instance two of these old mouths are seen, showing the hinge, also the central cardinal process, as well as the new one, within all of these mouths, are seen young specimens of *Calceola* attached, having the general characters of the adult. In two instances one of the vigorous young attached itself to the bottom of the cavity and eventually killed the old one, and then took complete possession.

I have one specimen of *C. attenuatus* two inches long (ventral valve), three-tenths inch wide at hinge, within the cavity of which stands another *Calceola* of the same species one and a half inch long, three-tenths inch at hinge; the apex of smaller is attached to the bottom of the cavity of the larger, and almost fills it; the cardinal process of larger is seen.

FURTHER NOTES ON THE MECHANICAL GENESIS OF TOOTH-FORMS.

BY J. A. BYDER.

In a paper published in the Proceedings of the Academy of Natural Sciences of Philadelphia,¹ in 1878, I sought to indicate the modes in which the teeth of mammals were modified by means of the movements of their jaws incident to mastication, through long series of generations. I there reached the conclusion that mechanical strains and impacts had probably been the secondary causes to which the origin of the various forms of teeth might, in large measure, be attributed. The teeth were supposed to be plastic, or at least slightly so, in all stages, notwithstanding their extreme hardness. This view was forced upon me by facts presented by vertebrate palæontology, together with my observation that the physiological act of mastication was progressively specialized, and in each case its degree of specialization was found to be in correspondence with the type of molar tooth with which it was associated. In the course of my studies it seemed clear to me that the tooth-modifying capacity resided in the powers of the animals themselves, and the ways in which they were *compelled*,² according to the kind of food for which they had a preference, to exert their powers. I am aware that this sort of reasoning amounts to saying that an animal causes its own structures to vary in form, by the natural operation of its own powers in overcoming resistances, which view, notwithstanding its seeming improbability, has more in its favor than that which holds that chance variations, which have been of benefit to individuals, have been preserved and transmitted to offspring and developed into organs in the course of generations by the operation of the law of natural selection, the importance of which I would be the last to underrate. The latter view gives us no causal interpretation for so-called spontaneous

¹ "On the Mechanical Genesis of Tooth-Forms," pp. 45-80.

² Emphatically not wholly of their own wills, because the specialization of organization presupposes a certain limitation in the power to make choice caused by habits, which have become physiological characteristics, so that the charge made against Lamarckianism that it throws all outside power out of consideration, no matter of what character, is utterly false on scientific grounds alone.

variations, which the view here advocated, in some cases at least, affords; though I do not wish to be understood as saying that it gives such an interpretation in a large proportion of instances where the history of the interacting modifying forces are as yet perhaps imperfectly known. Natural selection is quite adequate to account for the development of an organ, or part, after it has made its appearance, but it leaves the initial step causally unaccounted for, which, it must be confessed, is the point where the Lamarckian hypothesis seeks to supply the needed differentiating causes. The hap-hazard, causeless variation of organisms cannot, in the nature of things, exist; it is contrary to all known precedent as exhibited in the phenomena of the inorganic world.

In studying the teeth, one is confronted by a number of large series of forms which clearly demonstrate the fact that large numbers of allied species which have succeeded each other in geological time bear a genealogical relation to each other. The earliest forms of teeth being the simplest, the later ones seem to have been derived from them by a process easily understood, if mechanically interpreted. The tooth earliest developed of all, seems to have been a simple hollow cone superimposed upon a nutrient papilla; indeed the enamel and dentinal portion seems to be developed from its superficial (epithelial) layers of cells which elongate as they grow and crowd together, becoming columnar, whilst the excessively hard salts of lime constituting the dentine and enamel are deposited around the columnar matrix of cells or odontoblasts by secretion, leaving a fine tubular cavity in the centre, from which the odontoblasts retreat as their substance is crowded out by the

exerted and repeated millions, perhaps billions of times in the course of generations, be effectual in transmitting the simple primary form to a more complex later one, as I have tried to show more fully in the paper already cited. That a brittle inflexible substance like marble, when in the form of thin, rectangular slabs may be bent by the force of gravity acting upon it persistently whilst lying horizontally for a long time and only supported at two of its corners diagonally opposite each other, is proved by an old marble gravestone very much bent from this cause and now belonging to the Academy. This phenomenon it seems to me is no harder to explain than the morphological phenomena presented by the teeth of mammals; for my part, I believe that both the phenomena in question will most probably bear a similar interpretation.

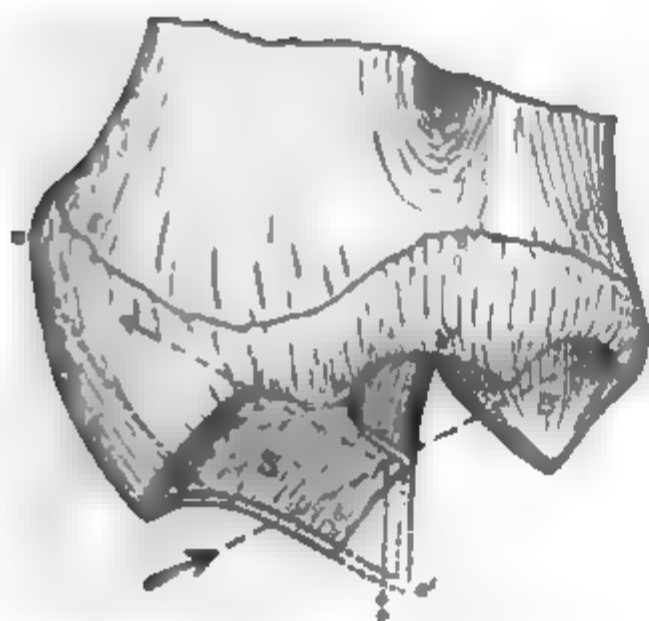
I now propose to offer some new evidence based upon more accurate observations of the mode in which herbivorous ungulates crush and masticate their food. A large living male rhinoceros has afforded me the opportunity to make the observations. *I distinctly saw this creature crush its food by sweeping the lower molars of the side about to be brought into action, from without inwards against the upper ones*; meanwhile those on the other side of the head were of course scarcely in contact, provided a considerable amount of food was being acted upon by the side in use at the instant. This, I concluded, for obvious reasons, was definitely the mode in which the jaws of ungulates were used which were moved in both lateral and vertical directions in the act of chewing; in other words, it seems to be the manner in which chewing is effected in all anisognathous selenodont mammals, which can be definitely traced to a bunodont ancestry.

It will be readily understood that the above observations in some measure modify the conclusions reached in my former paper, in which the belief was entertained that the motion which did the crushing was outwards instead of inwards. From facts which I have gathered, it now seems strange to me that I should have fallen into this misapprehension, since the true method promises to yield even a better interpretation of the true philosophy of tooth-modification by mechanical agencies than that first offered. It must, however, here be stated that, in no essential particular except one, do I alter my former views. I still hold the mandibular

articulations to be the principal odontomorphic centres, as all mandibular movements are regulated from them as axes.

From the fact that the movements are from without inwards in selenodonts generally, the outer series of cusps, in the advent of such lateral movements, seem to be most compressed laterally and their tips most deflected in an inward direction, and I shall therefore consider the cause as acting from the outside instead of from the inside as formerly. The paleontological evidence afforded by symborodonts, where the selenodont or crescent-shaped cusp first appears in the outer row of molar cusps, whilst the inner row is still bunodont, is pretty conclusive. This singular combination of cusp characters is also exhibited by *Titanotherium*, *Palæosynops*, etc. Other series of ungulates show the almost synchronous development of the crescent-shaped cusps in both outer and inner rows, but earlier forms seem to indicate pretty unanimously that the outer or buccal series are the first to be differentiated. In *Coryphodon*, figured by Cope,¹ is exhibited the inward flexure and flattening of the exterior rows of cusps of the upper molars, in a perhaps unparalleled degree.

The change of view is simply in regard to the manner in which the modifying force is applied, and does not change the principle involved, which assumes broadly that the lateral mandibular movements produce lateral changes in dental forms, whilst on the other hand reciprocating ones produce antero-posterior and postero-anterior ones. Having definitely concluded as to the direction of the action of the forces, in evidence of which a great catalogue of facts might be adduced, more indeed than my space at present



and a'' , the apical portion worn off being restored in outline. This shows that S has been deflected in an inward direction, and indicates that the force operative in causing the deflection has been constantly active from one side, or that upon which the large arrow is placed pointing in the direction of the dotted line. The total displacing force exerted by the jaw

moving in an inward direction during the entire lifetime of the animal may be supposed to be represented by this arrow, plus that of its ancestry, during the existence of which the tooth has been brought to its present form by the mechanical process of differentiation indicated. The muscular power or crushing force exerted by the mandibular muscles (the coefficient of which is 104 pounds per square inch of section, *Haughton*) in an upward direction indicated by the lower smaller arrow pointing upwards in the direction of the entire vertical line, would tend while the mandible is moving inwards and obliquely upwards to act as a wedge upon the somewhat oblique faces of the upper molars, forcing them outwards in the direction of the dotted line and arrow pointing towards a . In this way the cause of the anisognathism is accounted for, whilst it is also not to be forgotten, that the influence of this peculiar combination of forces cannot be without effect in producing modifications upon the crowns of the teeth from within, so that in reality, modifying forces may be at work from both sides.

ON THE STRUCTURE OF THE CHIMPANZEE.

BY H. C. CHAPMAN, M.D.

The literature on the anatomy of the Chimpanzee is much more extensive than that on the Gorilla, the animal having been dissected by Tyson,¹ Traill,² Vrolik,³ Schroeder Van der Kolk,⁴ Wyman,⁵ Marshall,⁶ Rolleston,⁷ Wilder,⁸ Huxley,⁹ Gratiolet and Alix,¹⁰ Turner,¹¹ Humphrey,¹² Broca,¹³ Macalister,¹⁴ Bischoff,¹⁵ Champneys,¹⁶ and others. It may appear, therefore, superfluous to offer the results of my dissection of the female Chimpanzee, *Troglodytes niger*, which recently died at the Zoological Garden of this city. In comparing, however, the accounts of the authors just referred to, it becomes evident that the animals dissected by them must in some instances have been different species of Chimpanzees, and in others that they exhibited individual peculiarities. The above accounts are, moreover, often limited to only portions of the body. Indeed, the only elaborate modern treatises I have seen are those of Vrolik and Gratiolet. The admirable monograph of Tyson, old as it is, may still be consulted with the greatest advantage. I propose confining myself to a general account of the Chimpanzee I dissected, calling attention more particularly to the points in which it differed from those previously described, and the general resemblances and differences between it and the Gorilla and Man. The specimen dissected by me was a female, supposed

to be about five years old, and measured $28\frac{1}{2}$ inches from crown of head to sole of the feet. The upper extremity of right side measured from shoulder to end of middle finger 18 in.; the lower extremity measured from the head of the femur to the end of the middle toe of the right side $16\frac{1}{2}$ inches. The hand, taken from the wrist to the end of the middle finger, measured, on the right side, $5\frac{1}{2}$ in. The right foot, considered from homologous points, was $5\frac{1}{2}$ inches long. As in the young Gorilla, so in the young Chimpanzee, Plates IX. and X., the resemblance of the head to that of a human being of an uncivilized race is more striking than in the adult. The distinction between the hand and foot in the Chimpanzee is not, however, so well marked as in the Gorilla—the foot, superficially considered, resembling a hand. As we shall see, however, this is only a functional difference, the lower extremity in the Chimpanzee terminating structurally in a foot just in the same sense that a man's does, all of the apes and monkeys being anatomically bimanous and bipedous, and not quadrumanous. The hand in the Chimpanzee is larger than the foot.

Cervical Region.—On removing the skin I noticed a well-developed platysma myoides, and so far as I could see this was the only representative of the panniculus carnosus muscle of the lower animals, with the exception, perhaps, of a few scattered fibres in the fascia of the hand corresponding to the palmaris brevis of Man. The external jugular vein was quite evident. Next in order came the superficial cervical plexus of nerves and the sternocleido mastoid muscle, which differed from that of Man in being divided into sternal and cleidal portions, the cleidal portion arising a little lower than the sternal, and the insertions being equally distinct. The spinal accessory nerve separates the two parts of this muscle, and differs in this respect from the disposition given by Vrolik, as well as in the fact that its internal root joins the pneumogastric. From this latter nerve the superior and inferior laryngeal nerves pass off to supply the larynx, the inferior passing around the subclavian artery on the right side and the aorta on the left, as in man. There was nothing particularly noticeable in the distribution of the glosso-pharyngeal, lingual branch of the 5th, or the hypoglossal nerves, this latter winding around the external carotid artery, passing over the hyoglossus muscle and under the mylohyoid to be lost in the tongue. The pneumogastric was well developed, as also the stylo-glossus, stylo-

hyoid, and stylo-pharyngeus muscles. Anteriorly I noticed the sterno-hyoid, sterno-thyroid, and thyro-hyoid, and the little crico-thyroid artery passing across the crico-thyroid membrane. Laterally the omohyoid muscle was well developed. It was held in position by the little band of the cervical fascia, and served, with the sterno-cleido mastoid muscle, to divide the neck, topographically speaking, into the triangles. I noticed that the muscle sometimes called the omo-cervicalis was well developed. This muscle arises from the transverse process of the atlas, and is inserted into the clavicle; it was very properly described by Tyson as the elevator of the clavicle. It has been found in Man as an anomaly. Very human in its appearance was the disposition of the phrenic nerve lying upon the scalenus anticus muscle, and coming from the 3d and 4th cervicals. The muscle separated the subclavian vein from the artery, and between it and the scalenus medius the brachial plexus emerged. The whole cervical region was strikingly human in its disposition, and with the exceptions of the sterno-cleido mastoid muscle being divided into two, and in the presence of an omo-cervicalis muscle, the neck of the Chimpanzee would serve the surgical anatomist as material for a demonstration quite as well as that of a human being. On raising the clavicle the subclavius minor and coracoid ligament were seen well developed; the pectoralis muscle, however, presented a difference from that of Man, as it arose from the 2d and 3d ribs, and was inserted into the head of the humerus. The axillary region was very human in its appearance; the anterior and posterior thoracic nerves and the intercosto-humeral were well de-

pared with the same muscles in man. In the forearm the pronator radii teres arose by two heads, the median nerve passing between them as in Man, whereas I found only one head in the Gorilla. The palmaris longus was well developed: whereas it was absent in the Gorilla I dissected. Flexor sublimis digitorum and profundus were more split up than in Man, but as a whole there was no marked difference between them and those of Man. The flexor longus pollicis, joined to the perforator of the index, was to a certain extent differentiated from the flexor profundus digitorum, its tendon passed between the two heads of the flexor brevis pollicis. The other muscles of the thumb and those of the little finger compared favorably with those of Man; the lumbricales were large. The supinator longus arose from the humerus much higher up than in Man. The extensor ossi metacarpi pollicis terminated in two tendons; the secundii internodii pollicis was present, but there was no extensor primi-internodii. I found this muscle, however, in the Gorilla. The extensor indicis and extensor minimi digiti terminated in their respective digits singly, whereas in the lower monkeys the middle finger is supplied by a slip from the indicis, and the ring finger with one from the minimi digiti in addition to the tendons of the extensor communis. According to some anatomists the extensor indicis in the Chimpanzee supplies both index and middle fingers. The Chimpanzee seems, from the above brief sketch of the muscular system of the upper extremity, to be closer allied to Man than the Gorilla, inasmuch as the pronator arises by two heads and in having a palmaris longus and a flexor longus pollicis, but it differs from the Gorilla and Man in that the extensor ossi metacarpi divides into two tendons, and in there being no extensor primi internodii pollicis.

Lower Extremity.—Traill,¹ in his account of the Chimpanzee, figures a muscle, which he called the scansorius, rising from the ileum and inserted into the femur. This muscle appears to me to be simply a part of the gluteus minimus. According to Vrolik² the tensor vaginæ femoris had been confounded with the so-called scansorius by Traill, but in my specimen the former muscle was very well developed, and I should not have noticed any thing particular about the gluteus had not a portion of it been described

¹ Traill, *op. cit.*, Plate I. Fig. 1.

² Vrolik, *op. cit.*, p. 21.

separately as the *scansorius*. The rotators of the thigh were present. The adductors are five in number. The *semimembranosus* and *semitendinosus*, as in the Gorilla, hardly deserve names characteristic of their homologues in Man, as they are quite muscular. The *gracilis* is very large. The *sartorius*, however, rather slender. There was a well developed *popliteus*, but no *plantaris* muscle. The *soleus* arose by the fibular head only. As regards the anterior aspect of the leg, the *tibialis anticus* splits into two tendons, the *extensor longus digitorum* was present, but the so-called *peroneus tertius* was absent. The *extensor longus hallucis* and *extensor brevis digitorum* were well developed, as also the *peroneus longus* and *brevis* on the fibular side of the leg. The *flexor accessorius* was absent. The *flexor brevis digitorum* supplied the second and third toes only, the tendinous slips for the fourth and fifth came from the *flexor longus digitorum*; whereas in the Gorilla the slip for the fifth came from the *flexor longus hallucis*. In the Chimpanzee the slip for the fifth toe is very delicate, and, like that of the Gorilla, is not perforated. There is quite an intimate union between the fibres of the *flexor longus hallucis* and *digitorum*. The special muscles of the *minimi digiti* and *hallux* are well developed, and in addition to the ordinary *flexor brevis hallucis* I noticed a delicate muscular slip arising from the *calcaneum* in common with the *flexor brevis*, which was inserted into the phalanx of the *hallux*. Its action was to flex the *hallux*. This little slip was also seen in the other foot. So far as I know it has not been described before in the Chimpanzee. There was no *transversus pedis*. The little slip, called by Prof. Huxley the *abductor ossis metacarpi*



arranged in the form of a V, as in man, and not a T, as has been found to be the case in other specimens. The parotid gland was large, the duct of Steno crossed the masseter. The submaxillary was absolutely very large. The stomach was very human in shape. The length of the small intestine was eight feet, that of the large two and a half. The vermiform appendix measured six and a half inches. The Peyer's patches in small intestine were very striking. There are no valvulae conniventes. There was nothing peculiar about the spleen or pancreas; in reference to the liver the quadrate lobe was not well differentiated, and the caudate lobe was thick rather than caudate. I noticed an interesting fact in reference to the peritoneum: When the great omentum was raised the transverse colon was seen to be attached to its under surface, as in Man; whereas in other monkeys and the lower mammals the transverse colon is quite separate from the great omentum. This condition is also seen in the human fetus, but, as development advances in it, the peritoneum covering the transverse colon becomes adherent to the great omentum, and ultimately in Man appears as one structure. In this respect the Chimpanzee agrees with Man and differs from the monkeys. I do not know whether this disposition has been observed before in the Chimpanzee or the other anthropoids. I suspect the same disposition obtains in the Gorilla.

Respiratory and Circulatory Systems.—As is well known, in the male Chimpanzee and the other anthropoids, the ventricles of the larynx are enormously dilated, these pouches extending up into the neck, even under the trapezius muscle and over the breast into the axillae. Noticing during life that the voice of the female Chimpanzee was so much weaker than her mate, I was prepared to find these ventricular pouches very rudimentary, even if developed at all. According to some anatomists these pouches have no influence upon the voice.

The pouches, however, extended even in the female up to the hyoid bone and base of the tongue. The crico-thyroid, thyro-arytenoid crico-arytenoid, lateralis and posticus, and arytenoid muscles were well developed. The inferior vocal cord, or more properly vocal membrane, was of a triangular shape, and quite distinguishable from the remaining part of the mucous membrane. The right lung was divided into three lobes, the left into two, as in Man. I noticed that the left carotid and left subclavian arteries came

off from a common vessel, a short innominate, differing in this respect from the Gorilla and Vrolik's¹ Chimpanzee, which in the disposition of its great bloodvessels is like that of Man.

Genito-urinary Organs.—Believing that the transitory stages through which a human being passes in utero are often permanently retained through life in the lower animals, it appeared to me that the best way of determining the question as to whether the Chimpanzee had the external and internal labia of the human female was to compare my specimen with a human female fetus. The opportunity of examining two negro fetuses about five months old, presenting itself at the same time that I was dissecting the Chimpanzee, I compared the generative apparatus of all three, and I am satisfied that they are morphologically essentially the same, for in the Chimpanzee there is a well-developed clitoris, with frenum and prepuce, below the frenum the internal labia are undistinguishable from the external, and these latter are undeveloped above the clitoris. The whole appearance of the uterus, vagina, and ovaries in the Chimpanzee is also similar to the internal organs of the human fetus. The bladder was large, and the kidneys resembled those of man in their form, and differed from that of the Orang in having more than one papilla.

The Brain.—The brain of the Chimpanzee has been described by several anatomists, and figured by Tyson, Tiedmann,² Vrolik, Schroeder van der Kolk,³ Gratiolet,⁴ Rolleston, Marshall, Turner, Bischoff, Broca, and others. As the existence of a "posterior lobe, posterior cornu, and hippocampus minor" in the brain of the Chimpanzee and other apes and monkeys gave rise to a memorable discussion some years ago, it was with great interest that I hastened, as soon as possible after death (a few hours), to open the skull of the Chimpanzee, and to examine the brain *in situ*. The brain weighed 10 ounces 10 grains. I confess to my great surprise, I found the cerebellum uncovered by the cerebrum to the extent shown in the illustrations, Plate XI., Figs. 1 and 2, and XII., Figs. 1 and 2, and remembering Prof. Huxley's criticism that⁵ "his error must become patent even to himself if he try to replace the brain

¹ Vrolik, *op. cit.*, Plate VI. Fig. 4.

² Philos. Transactions, 1836.

³ Schroeder Van der Kolk and Vrolik, Amsterdam Verhandelingen, 1849.

⁴ Plis cerebraux de l'Homme, 1854.

⁵ Man's Place in Nature, p. 97.

within the cranial chamber," I did so, and yet the cerebellum remained uncovered. Is it possible that in my young female Chimpanzee the posterior lobe had not attained its full growth, or that in some Chimpanzees the posterior lobe covers the cerebellum, and in others it does not? According to Prof Huxley, this is the case among the Gibbons, for in referring to the Siamang, he says this "is remarkable, for the short posterior lobes of the cerebrum which in this anthropomorphous ape do not overlap the cerebellum, as they do in all the others." On the other hand, Prof. Bischoff observes in his *Beiträge* on the Hylobates, "Dagegen kann ich Flower und Huxley darin nicht beistimmen das die hinteren Lappen des grossen Gehirns eine sehr bemerkenswerthe Reduktion gegen die der Gehirne der anderen Anthropoiden darin zeigen, dass sie das kleine Gehirn nicht mehr völlig bedecken. Bei meinem Hylobates ist das kleine Gehirn vollständig durch die Hinterlappen des grossen Gehirns bedeckt." It appears to me more likely that in some Gibbons the cerebellum is covered, and in others not, than that such eminent anatomists as Professors Huxley, Flower, and Bischoff should be opposed in reference to a mere matter of observation, and so with regard to the diversity of opinion as to the cerebellum being covered by the posterior lobes of the cerebrum in the Chimpanzee.

According to Huxley, Rolleston, Marshall, Gratiolet, etc., the cerebellum is covered by the cerebrum in the Chimpanzee.

In the figures of the Chimpanzee given by Tyson, Tiedemann, Vrolik, Schroeder Van der Kolk and Vrolik, the cerebellum is uncovered by the posterior lobes of the cerebrum. Tiedemann says "The hemispheres of the brain are relatively to the spinal marrow, medulla, cerebellum, etc., smaller than in man." According to Vrolik, the Chimpanzee brain is distinguished from the human "par un moindre développement des hemisphères du cerveau qui ne recouvrent tout le cervelet." Gratiolet, in referring to the figures of the brain of the Chimpanzee, in Schroeder Van der Kolk's and Vrolik's paper in the Amsterdam Verhandelingen for 1849, speaks of the brain as being "profondément affaissé." Now, while these eminent anatomists admit the justness of Grati-

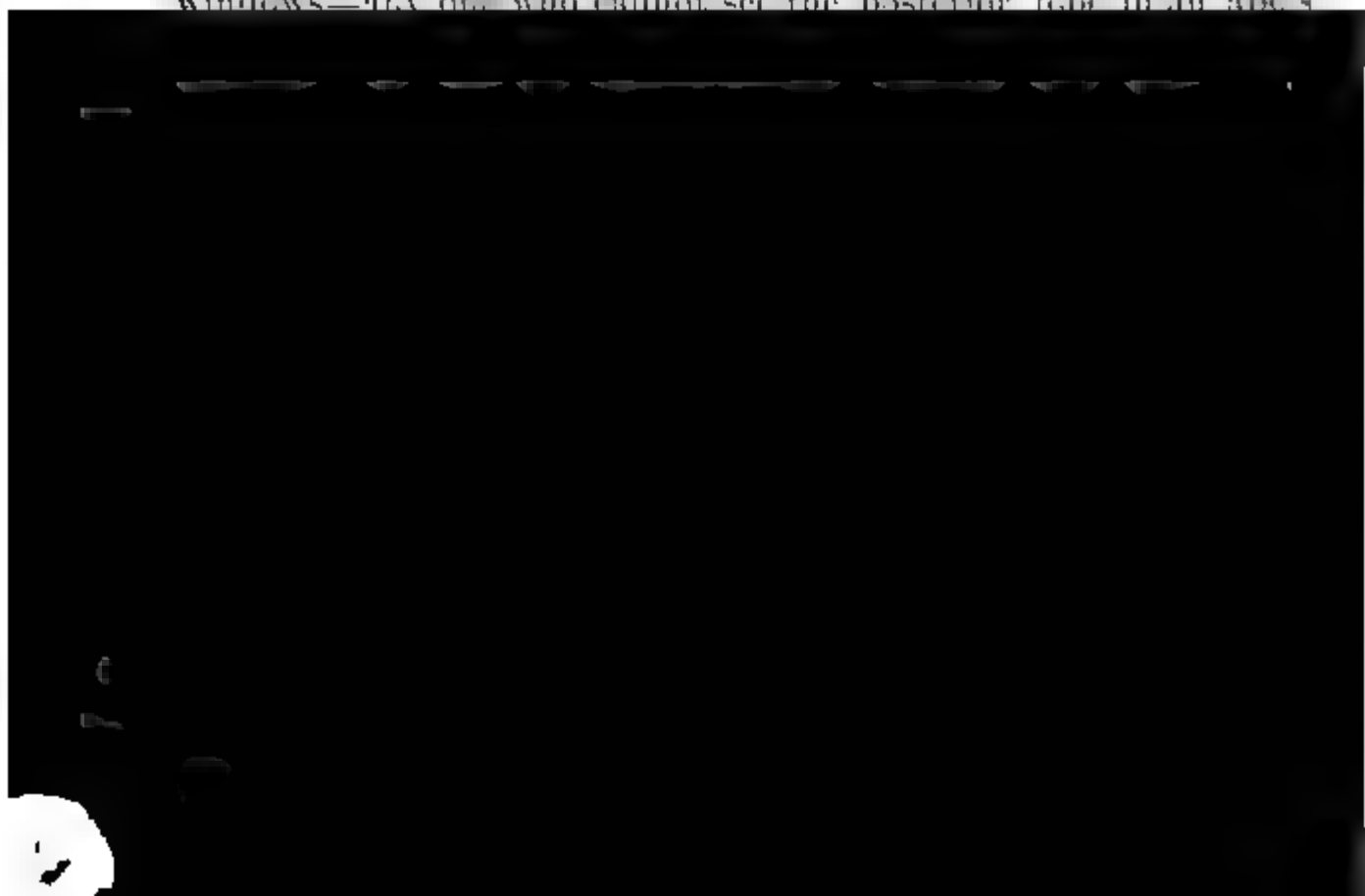
* Anatomy of Vertebrates, p. 410

* Beitzge, etc., Münch Aband, 1870, p. 272

* Philos Trans, p. 518.

* Recherches, p. 89

olet's criticism, yet they observe in their "Note sur l'encephale de l'Orang," in the Amsterdam Verslagen for 1862, page 7, "A vrai dire, ce lobe postérieur ou occipital ne se prolonge pas autant que chez l'homme; il ne recouvre pas si bien le cervelet, du moins il ne le cache pas complètement surtout vers les cotés; mais il n'y a rien là dedans, qui nous empêche de lui donner le nom qui lui est dû. Par rapport au développement du cervelet, nous ne croyons pas faire une chose inutile en rappelant que, d'après les mesures que nous avons publiées en 1849, le cervelet du Chimpanzé et de l'Orang est proportionnellement plus grand que celui de l'homme. Cela doit avoir une certaine influence sur la maniere dont il se trouve pour une partie à découvert chez ces animaux qui ont les lobes occipitaux moins étendus que ceux de l'homme." Their plate, Fig. 1, giving the brain of the Orang, shows quite plainly the cerebellum partially uncovered by the cerebrum. In my Chimpanzee the cerebellum was extremely well developed, as may be seen from Plate XI., Fig. 2. Should future investigation show that the posterior lobes of the cerebrum do not invariably overlap the cerebellum, as in the Chimpanzee dissections just referred to, and in the Orang of Vrolik and Gibbon of Huxley, it will only be another instance of the truth that the lower monkeys in some respects are more nearly allied to man than the Anthropoids, for I have found the cerebellum entirely covered by the cerebrum in the genera *Macacus*, *Cynocephalus*, *Semnopithecus*, *Ateles*, *Cebus*, etc. Prof. Huxley observes, "if a man cannot see a church, it is preposterous to take his opinion about its altar-piece or its painted windows—*ala ovis* who cannot see the posterior lobe in an ape's



the Chimpanzee as it was that the cerebellum was relatively to the cerebrum very much developed, Plate XII., Fig. 1.

Of late years the convolutions of the human brain have been very carefully described, and compared with those of the lower animals; among others, by Bischoff, Ecker, Gratiolet, Pansch, and Husche. And through the development of the theory, based upon pathological, experimental, and comparative anatomical facts, that, *ceteris paribus*, the grade of the intelligence is proportional to the number and complexities of the gyri and sulci, the comparison of the brain of an anthropoid with that of Man becomes very interesting. So far as I know, the first distinct statement that the convolutions are most numerous in the brain of Man, and that his superior intelligence is due to this, is to be found in the works of Eristratus, as quoted by Galen. In 1664 Willis called attention to the lower animals having convolutions, though fewer than Man, and that certain animals, like monkeys, had more of them than carnivorous ones, etc. Vicq. D'Azyr, in 1789, noticed the want of symmetry in the convolutions in the brain of Man. In 1794 Malacarne called especial attention to the convolution known as the gyrus fornicatus. Tiedemann, in 1816, treated of the development of the convolutions. While undoubtedly the anatomists just referred to may be said to have begun the study of the convolutions, nevertheless it appears to me that the credit of a systematic study of the folds and fissures in a group of animals, the comparison of such with those of Man, and the extension of such investigation to the mammalia generally, belongs to Prof. Richard Owen, who in 1833 distinguished in the Felidæ the folds by letters and the fissures by figures, and what is more, named them. In 1842 his views were much extended in the lectures delivered at the Royal College of Surgeons, when the homologous convolutions were brought out strikingly in the diagrams by colors. Leaving this little historical digression, and returning to the brain of the Chimpanzee, I think it may be stated that in most of the specimens examined so far all of the convolutions and fissures described in the human brain can be identified. There is no difficulty in recognizing the four lobes—the frontal, parietal, occipital, and temporal, Plate XI., Fig. 1; Plate XII., Fig. 1. The central lobe or island of Reil, which is very slightly convoluted, is entirely concealed in the Chimpanzee. The frontal lobe exhi-

bits the upper, middle, and lower frontal convolutions,¹ separated by the upper and lower frontal fissure, the latter passing into the vertical frontal (precentral). The central fissure (Rolando) is well marked, a little more forward in the Chimpanzee than in Man, separating the anterior and posterior central convolutions. The fissure of Sylvius is in such relation with the interparietal and temporal fissures, that the supra-marginal and angular convolutions are identical with those of Man. The "ascending branch" of the Sylvian fissure also passes in between the middle frontal and precentral fissures as in Man. The first, second, and third temporal convolutions, with the first and second temporal fissures, are as distinct in the Chimpanzee as in Man, and the continuity of the occipital and temporal lobes through the lower temporal convolutions (3d and 4th plis de passage of Gratiolet) is as unbroken in our ape as in the human being. Further, the three convolutions of the occipital lobe, with its transverse occipital and inferior longitudinal fissures, do not present any very marked differences from the homologous structure in Man. Up to this point I believe I have made no statements in reference to the fissures and convolutions of the brain of the Chimpanzee which have not been substantially made before. There has, however, been, and is still, a diversity of opinion in reference to the parts of the occipital convolutions which bridge over the external perpendicular fissure, which seems to be a continuation of the internal perpendicular or parieto-occipital fissure. The convolutions which I have referred to above as the upper and middle occipital convolutions pass in Man and *Ateles* so insensibly into the upper parietal

upper occipital convolution in Man being more superficial than in the ape. The upper occipital convolution, according to Huxley and Gratiolet, is absent in the Chimpanzee, but has been found at least on one side in the specimens described by Rolleston, Marshall, Turner, and Broca. The upper and middle occipital convolutions, so far as I have been able to compare them, seem to correspond to the convolutions described under the names of "Plis de passage," "Bridging," "Annectant gyri," and "Obere, innere und aussere Scheitelbogen-Windungen." The only other peculiarity that I noticed in the Chimpanzee was in reference to the parieto-occipital fissure of the right side, which did not reach the calcarine, being separated by the "deuxieme plis du passage interne" of Gratiolet, and that on both sides the calcarine fissure passed into the hippocampal, so that the gyrus fornicatus did not pass into the convolution of the hippocampus as in Man. In this latter respect, however, *Ateles Paniscus*, one case of *Hylobates*, and Turner's Chimpanzee agree with Man and disagree with all the other monkeys. The mesial side or the base of the brain did not present anything very different from Man, so far as they were susceptible of examination. The nerves coming from the base of the brain were, however, relatively very large. With all deference to Prof. Bischoff, I cannot agree that the "Kluft zwischen der hohen Entwicklung der Grosshirnwindung des Menschen und derjenigen des Orang oder der Chimpanse lässt sich nicht ausfüllen durch Hinweisung auf die Kluft zwischen der Entwicklung dieser Windungen zwischen dem Orang oder Chimpanse und Lemur. Letztere ist ausgefüllt durch die zwischen beiden liegenden Arten der Affen. Die Ausfüllung der ersteren muss noch gefunden werden."¹ On the contrary, it appears to me that on the whole the gap between the brain of the Chimpanzee and Man is less than that between the Chimpanzee and the lower monkeys; and, though it is not generally considered so, that the brain of the Chimpanzee resembles that of Man quite as closely as that of the Orang.

Résumé.—In considering the Chimpanzee in the totality of its organization, it appears to me to be as closely allied to Man as the Gorilla, but it must be remembered that, like it, in the absence of certain muscles, etc., the Chimpanzee and Gorilla are both less like Man than the lower monkeys.

¹ Die Grosshirnwindungen, p. 493. Munich Aband. 1869.

MARCH 4.

Mr. THOS. MEEHAN, Vice-President, in the chair.

Thirty-six persons present.

MARCH 11.

The President, Dr. RUSCHENBERGER, in the chair.

Forty persons present.

The following papers were presented for publication:—

“On the Nudibranchiate Gasteropod Mollusca of the North Pacific Ocean,” by Dr. R. Bergh.

“On the Variability of *Sphaeria Quercuum*, Schw.,” by J. B. Ellis.

The death of Dr. J. H. McQuillen, a member, was announced.

Note on Opuntia prolifera, Eng.—Mr. THOMAS MEEHAN exhibited specimens of proliferous fruit of this species, sent by Mr. Jackson Lewis, of San Jose, California. The fruit of three years ago were still fresh and green, and these produced other fruit immediately succeeding the last year. Mr. Meehan remarked that similar cases were on record in Masters’ “Teratology,” and in connection with this species in Brewer and Watson’s “Flora of California.” The latter authors state that the proliferous fruit are always sterile; but in cutting open twenty from those exhibited, one was found with a perfect seed.

out of the other, and is in a great degree co-relative; and yet they are, in a great measure, antagonistic forces, and it is as useful to recognize them as such, as to note the distinction between leaf-blade and petiole, or liber cells and wood cells. Assuming the distinction between these two forces, we are able to express the true character of this abnormal formation. The reproductive force after influencing structure towards its especial object, had been again subjected by the growth, or, more properly, vegetative force, and it was thus enabled, though in an imperfect manner, to continue in the line of its especial function. Of course all of these distinctive powers in plants come down ultimately to varying phases of nutrition, and in this direction we are to look for the secret whereby nature is enabled to make up the innumerable forms and conditions of living things.

MARCH 18.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-nine persons present.

The deaths of the following members were announced: J. B. Knight, E. Spencer Miller, Clement Biddle, Henry J. Williams.

MARCH 25.

The President, Dr. RUSCHENBERGER, in the chair.

Seventy-three persons present.

A paper entitled "Notes on Amphiuma," by Dr. H. C. Chapman, was presented for publication.

Edw. D. Cope was elected to fill a vacancy in the Council, caused by the death of Dr. J. H. McQuillen.

Wm. L. Auchincloss and Joseph Mellors were elected members.

Wm. H. Leggett of New York, John M. Coulter of Hanover, Ind., and George Bentham, F.L.S., of London, were elected correspondents.

The following were ordered to be published:—

ON THE VARIABILITY OF *SPHÆRIA QUERCUM*, Schw.

BY J. B. ELLIS.

Among the Sphæriaceous fungi of Southern New Jersey, no species perhaps is oftener met with than *Sphæria Quercum*, Schw. And perhaps, it might be added, no species is more difficult to define and classify. Fries includes it among the "Confluentes," remarking (Elench. ii. p. 84) that many species of that section approach very near to the *Dothideas*. Berkeley, in "Grevillea," places it in *Melogramma*, taking that genus doubtless as defined in his Outlines of British Fungology, p. 391, and by Fries in Sum. Veg. Scan. p. 386. Tulasne, however, who had examined this species, did not include it his genus *Melogramma* (see his Selecta Fungorum Carpologia, vol. ii. p. 81).

On examining the two genera, *Melogramma* and *Dothidea*, it will be seen that there are no salient and unmistakable characters by which they may be distinguished. Tulasne, l. c., says of his genus *Melogramma*, "*Perithecia globosa ex parietibus nunc e parenchymate materno vix distinctis nec solubilibus, nunc contra sine negotio sejungendis facta;*" a definition which will include two different types of perithecia, viz., those with walls not separable from the substance of the stroma, and others with walls readily separable; in the former case scarcely distinguishable from *Dothidea*, in which genus the ascigerous nucleus is contained in cavities in the stroma without any distinct perithecium. Per-

is soon ruptured with many small openings where the perithecia are scattered, or with much larger gaps where several perithecia more or less distinctly confluent, are grouped together. On peeling off the epidermis, the perithecia are generally left adhering to the inner bark, though in some cases where the cuticle is thick and tough, as in the cherry, they adhere to the inner surface of the cuticle itself.

The mycelium which spreads over and penetrates the matrix consists of variously branched and anastomosing dark brown septate threads which are more luxuriant in proportion as the substance of the matrix is of a soft and spongy nature. This mycelium assumes at length a darker shade, so that the substance of the bark and the subjacent surface of the wood becomes finally almost black. The perithecia are always filled at first with a white grumous mass which is closely attached to the inclosing walls, and from which are slowly developed the organs of fructification. The mature perithecia at length become black within, and the upper portion breaks away, leaving the cup-shaped base attached to the matrix. Having now for several years studied these various forms I am satisfied that *Sphæria Quercuum*, Schw. includes all the following so-called species, viz., *Sphæria mutila*, Fr.;¹ *S. ambigua*, Schw.; *S. Meliæ*, Schw.; *S. entaria*, C. & E. in Grevillea, vol. 6, p. 14; *S. eriostega*, Id.; *S. viscosa*, Id., vol. 5, p. 34; *S. erratica*, Id., vol. 6, p. 95; *S. thyoidea*, Id., vol. 6, p. 14; *S. pyrospora*, Ell. Bull. Torr. Bot. Club, v. p. 46; *Botryosphæria pustulata*, Sacc. Fungi Veneti, Ser. IV. p. 3; *Dothidea venenata*, C. & E. in Grev., vol. 5, p. 95; *D. Cerasi*, Id., vol. 5, p. 34; *Thümenia Wisteriæ*, Rehm in Mycotheca Universalis, No. 971; *Melogramma Wisteriæ*, Cke., (Grev. vol. 7, p. 51), and probably *Sphæria Hibisci*, Schw.; *S. Persimmons*, Schw.; and *S. Cratægi*, Schw. *Valsa mahaleb*, C. & E. in Grev., vol. 6, p. 11, is also, according to my specimens, only the young and imperfectly developed state of the same thing. *Melogramma Aceris*, C. & E., Grev., vol. 7, p. 4, is also, without much doubt, to be included in the above list, though this species and *S. eriostega*, C. & E., are unknown to me except from the descriptions in Grevillea. Of all the others I

¹ At least as that species is represented in Rav. Fungi Caroliniani Exsiccati Fasc. III. No. 62. See also remark in Grevillea, vol. 4, p. 97, under *Melogramma Quercuum*, Schw.

have examined authentic specimens, most of them in all stages of growth.

In all these different forms the character of the fructification is the same, or at most there is only a slight variation in the size of the asci and sporidia, so that from a microscopical examination of the fruit alone it would be impossible to say to which of the above species any particular specimen should be referred. This similarity will be readily seen on examining the figures in Grevillea illustrating the species cited. All have the same broad clavate, obtuse, stipitate asci which are often subject to a kind of deformity, being bent almost double. The paraphyses are simple or sparingly branched, of a gelatinous nature, and, like the asci, soon dissolved.

The sporidia are two-ranked, mostly broad navicular, without septa, hyaline or filled with granular matter mixed with oil globules and become at length brown. Some of the sporidia are of a regularly elliptical shape; these are generally shorter and broader while the navicular sporidia are often much longer and narrower. The average size of the sporidia is about .03^{mm} long by .013^{mm} broad. In all the different forms the ascigerous perithecia are accompanied by others producing stylospores of the *Diplodia* or *Sphaeropsis* type. (*Sphaeropsis fibriseda*, C. & E., Grev. 5, p. 89. *Diplodia thyoidea*, C. & E., Grev. 5, p. 32.) These stylospores never assume the navicular form, but are always regularly elliptical, smaller than the ascospores, sub-hyaline and granular at first, soon becoming brown. Other perithecia are filled with minute hyaline oblong or subglobose microstylospores (spermatia) of

supposed that the formation of septa is only the first step in the process of germination; though unfortunately I can only conjecture this, as the sporidia which I have tried to cultivate on slides of moistened glass have thus far refused to germinate.

From an examination of the above notes it will be seen that, disregarding the somewhat variable ostiola, the various forms above noted differ from each other only in the fact that in some the perithecia are confluent and united in a partial stroma, while in others they are scattered and without any distinct stroma. The only question then is whether this variation alone is sufficient to constitute a specific difference? Were this variability in the vegetative character accompanied by a corresponding variation in the fruit, there could be but one answer; but as has been already stated, and as may be seen by referring to the figures published in Grevillea, and as I hope to show by the publication of actual specimens in the North American Fungi, the fructification in all these different forms is essentially the same. With just as much reason might a specific distinction be made between the cluster of culms sprung from a single grain of wheat planted in a good soil and the single culm from another grain growing in a poorer soil. This same variation in an allied species, *Sphaeria gyrosa*, Schw., was not considered by Fries as by any means sufficient to warrant a specific distinction. In his *Elenchus Fungorum*, vol. ii. p. 84, under *S. gyrosa*, he says: "Erumpunt hae tuberculosa composita e rimis corticis Quercus; sed in ligno decorticato, eadem aest omnino simplex, conferta, subconfluens, punctiformis absque stromate distincto; singularis morphosis sed in hac tribu non rara." These remarks apply as accurately, at least to the form on *Rhus venenata*, i. e., to *Dothidea venenata*, C. & E., as if made with reference to that particular case. If then these different forms are to be united, it only remains to decide whether they are to be referred to the genus *Sphaeria* or to *Melogramma* or *Dothidea*; or whether it would be better to follow the example of some of the transatlantic mycologists and create a new genus for this particular case. But as the number of new genera, many of them with characters sufficiently obscure, is every day increasing, it would seem better to avoid this latter alternative. Throwing aside next, in this case, the generic name of *Sphaeria*, from which genus the fungus under consideration may perhaps with propriety be excluded on account of the peculiar character of its perithecia,

there remains either *Dothidea* or *Melogramma* to be adopted. As remarked in Grevillea, vol. 5, p. 34, under *Dothidea Cerasi*, C. & E., that species is scarcely a good *Dothidea* for "the cells often approximate to perithecia; this remark applies equally well to *Dothidea venenata*, C. & E., and to all the other species enumerated.

There remains the genus *Melogramma*, with the characters of which our fungus, at least in its confluent forms, agrees sufficiently well; nor are the varieties in which the perithecia are scattered and single properly to be excluded. The fact that with age the upper portion of the perithecium falls away, leaving the base attached, shows that in every case there is at least the rudiments of a stroma to which the basal portion of the perithecium is permanently attached. A careful microscopic examination reveals the presence of this rudimentary stroma, formed from the condensed fibres of the mycelium at those points where the perithecia originate. Nor yet is the form of the sporidia inconsistent with the characters given by Tulasne to the sporidia of his genus *Melogramma*, viz.: "*Sporæ sæpius distichæ, lineari-lanceolatæ vel ovatæ et utrinque obtusissimæ, curvæ rectæve, pluriloculares aut continuæ, fucatæ, vel pallidæ.*" The sporidia in our fungus are not ovate it is true, but the elliptical form approaches so near to that shape that it hardly seems best to exclude the species on that account.

According to Tulasne, l. c., and Fries, Elench. ii. p. 85, *Sphæria Quercuum*, Schw. is the same as *Sphæria fuliginosa*, Pers., at least as that species is represented in the Exsiccata of Montg.

**ON THE NUDIBRANCHIATE GASTEROPOD MOLLUSCA OF THE NORTH
PACIFIC OCEAN, WITH SPECIAL REFERENCE TO THOSE OF ALASKA.**

BY DR. R. BERGH, COPENHAGEN.

PART I.

The fauna of the North Pacific in general has been but little explored. The number of the so-called Nudibranchiate Gasteropod Mollusca found in this region up to this time is rather small. But a few species have been mentioned or described, chiefly by Tilesius, Eschscholtz, and Gould, and the number of forms is much smaller than that which is known from the North Atlantic in the same latitudes. There does not, however, seem to be any reason for a smaller number in the Pacific than in the Atlantic.

Mr. Dall has been engaged since 1865 in prosecuting researches in regard to the marine invertebrates of the region lying between America and Asia, from latitude 50° to latitude 70° N., including the coasts of Alaska, formerly Russian America, the Aleutian Islands, Bering Sea and Strait, and a part of the Arctic Ocean north of the strait.

Mr. Dall kindly invited me, who during a series of years have been engaged with studies upon Nudibranchiates, to examine and describe the collections relating to this group; these were received in the summer of 1876. It has been necessary to include, for comparison, the results of the examination of some few Atlantic species. Dall did not give particular attention to the Nudibranchs; yet, while a comparatively small number of forms and specimens have been obtained during his cruises, the number is sufficient to give some idea of the character of this particular fauna and to enrich our knowledge of the groups with several new forms. This will be obvious from the following list:—

NUDIBRANCHIATA OF THE NORTH PACIFIC.

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| 1. <i>Aeolidia papillosa</i> (L.). | 4. <i>Flabellina iodinea</i> (Cooper). |
| 2. <i>Aeolidia</i> (? var.) <i>pacifica</i> , Bergh,
n. sp. ? | 5. <i>Hormissenda opalescens</i>
(Cooper). |
| 3. <i>Coryphella</i> , sp. | |

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| 6. <i>Piona marina</i> Försk., var. <i>Pacific</i> a, Bergh. | 17. <i>Acanthodoris pilosa</i> (O. F. Müller), var. <i>purpurea</i> , Bergh. |
| 7. <i>Dendronotus purpureus</i> , Bergh, n. sp. | 18. <i>Acanthodoris coerulescens</i> , Bergh, n. sp. |
| 8. <i>Dendronotus Dalli</i> , Bergh, n. sp. | 19. <i>Lamellidoris dilamellata</i> (L.), var. <i>pacific</i> a, Bergh. |
| 9. <i>Tritonia tetraquetra</i> (Pallas). | 20. <i>Lamellidoris varians</i> , Bergh, n. sp. |
| 10. <i>Archidoris Montoreyensis</i> (Cooper). | 21. <i>Lamellidoris hystericina</i> , Bergh, n. sp. |
| 11. <i>Diaulula Sandiegensis</i> (Cooper). | 22. <i>Adalaria pacifica</i> , Bergh, n. sp. |
| 12. <i>Oadlinarepanda</i> (Ald. & Hanc.). | 23. <i>Adalaria virescens</i> , Bergh, n. sp. |
| 13. <i>Oadlinarepanda pacifica</i> , Bergh, n. sp. | 24. <i>Adalaria albopapillosa</i> (Dall). |
| 14. <i>Chromodoris Dalli</i> , Bergh, n. sp. | 25. <i>Akidoris lutescens</i> , Bergh, n. sp. |
| 15. <i>Chromodoris californiensis</i> , Bergh, n. sp. | 26. <i>Triopa modesta</i> , Bergh, n. sp. |
| 16. <i>Acanthodoris pilosa</i> (O. F. Müller), var. <i>albescens</i> , Bergh. | 27. <i>Polycera pallida</i> , Bergh, n. sp. |

An examination of the foregoing list¹ first shows a quite northern character of the forms examined, excepting the two species of *Doridæ* (*Chromodoris*) which actually come from and are usually characteristic of a more southern region than the others. Secondly, the species examined agree with North Atlantic forms, being either identical or mere varieties of them, or at least nearly allied species.²

ÆOLIDIIDÆ

The *Æolidiidæ*³ have representatives in all the seas of the world, but seem, as far as can be judged from the rather meagre accounts

of them, to be less abundantly distributed through the warm and tropical regions. This seems evident from the information given by Van Hasselt, Kelaart, Alder and Hancock, Collingwood and Pease, as well as by Semper.¹ Van Hasselt has only three forms of *Aeolidiidae*, Elliott (Alder and Hancock) four or five, Kelaart nine. Collingwood was rather astonished at the small number of species and individuals which were found on the coasts of China: Formosa, Labuan, and Singapore, and which included no *Aeolidiidae* at all. The Pacific seems especially poor in *Aeolidiidae*, particularly in its northern and eastern part. The exploration of Alaska, under the direction of Mr. W. H. Dall, has only furnished five or six forms of this group belonging to the genera *Aeolidia*, *Fiona*, *Coryphella*, *Flabellina*, and *Hermisenda*.

I. AEOLIDIA, Cuvier.

Aeolidiana Quatrefages, Ann. Sci. Nat. Zoöl., Sér. i, t. iii. p. 134, 1844.

Aeolidia (Cuvier), R. Bergh, Anat. Bidr. til Kundsk. om Aeolidierne, Danske Vidsk. Selsk. Skr. 5 R. vii. 1864, p. 199.

Aeolidia, R. Bergh, Beitr. zur Kenntn. der Aeolidiaden, I. Verh. der K. K. zool.-bot. Ges. in Wien, xxiii., 1873, pp. 618-620; ii. l. c. xxiv. 1874, pp. 395-396.

Corpus sat depressum, rhinophoria simplicia, papillæ² caducæ, compressæ. Podarium antice angulatum mandibulæ applanatæ, processu masticatorio non denticulato. Radula dentibus uniseriatis, regulariter arcuatis, pectiniformibus instructa.

This genus is easily distinguished by its depressed form, the simple rhinophoria, the flattened papillæ, and the straight front margin of the foot, with nearly rounded edges. The mandibles are rather short, very much flattened, the cutting edges simple;

Menke), *Eolida*, *Eolidia*, and *Aeolidia* by different authors. It may be best, as I have done for many years, to adhere to the original Cuvierian way of writing it. Cf. my Unders. af *Fiona atlantica*, Natur. Hist. Foren. Vidsk. Meddel. for 1857, p. 276, 1858.

¹ Cf. my Malacol. Untersuch. (Semper, Reisen im Archipel der Philippinen II. ii.) Heft 1, 1870, p. 1.

² I always use the term *papillæ* instead of the more usual one of *branchiæ* or *cirrhi*, partly because it is the Linnean term, partly because the organs do not exclusively serve for respiration, which is partaken of by the whole surface of the skin, that over the papillæ as well as elsewhere, among all the *Nudibranchiata*.

the teeth of the radula comb-shaped, not emarginated in the middle. The genus is unarmed.

The spawn of the typical species is known,¹ and something of the development.

Only a few species of this genus are hitherto known, and very likely the Pacific forms will not prove specifically distinct from the typical species, which is found widely spread over the northern part of the Atlantic, on the coasts of America as well as of Europe.

1. *Aeolidia papillosa* (L.).

Gould, *Inv. Mass.*, ed. Binney, p. 240, Pl. XVIII. f. 258, 1870.

Meyer and Möbius, *Fauna der Kieler Bucht*, I. p. 29, f. 9, 10, 1865.

Hab. Oc. Atlant. septentr.

2. *Aeolidia serotina*, Bergh.

R. Bergh, *Beitr. zur Kennt. der Aeolidiaden*; *Verb. der K. K. Zool.-bot. Ges. in Wien*, xxiii. 1873, p. 619.

Hab. Oc. Atlant. septentr.

1. *Aeolidia papillosa* (L.).

Hab. Oc. Pacificum (Sanborn Harbor, Nagai, Shumagin Islands, Alaska Territory).

Only one specimen of this species was taken by Dall in July, 1872, in Sanborn Harbor (Shumagin Isl.) at low water on rocky bottom.

According to Dall the color of the living animal was yellowish-white; the color of the animal preserved in spirits was also uniformly yellowish white. The length was about 15.0 mm., with a

between them short, equalling about one-sixth of the longitudinal diameter of the ganglion; the gastro-œsophageal ganglia nearly one-sixth of the buccal ones in size, with one very large and two rather large cells, their stalk a little longer than the commissure between the buccal ganglia.

The *eye* has quite black pigment, and a yellowish lens. The otocyst is situated some distance behind the eye, and is filled with otoconia of the usual kind.

The *bulbus pharyngeus* is of the usual size, about 5.0 mm. long, 3.0 mm. broad, 3.5 mm. high; its form is as usual. The jaws exactly as in the typical *Ae. papillosa*. The radula contained thirteen teeth, beside seven mature and two immature teeth in the sheath, twenty-two altogether. The anterior plate was about 0.25 mm. broad, the posterior one about 0.75 mm.; yellowish horn colored; there were thirty-two denticles on the former and forty-two on the latter.

2 *Aeolidia papillosa*, var. *Pacifica*, Pl. I. f. 1-6.

Colore e flavido albescens.

Hab. Oc. Pacific septentr. (Chignik Bay, Aliaska Pen.).

Three specimens of this form were taken by Dall on mud flats at low water in Chignik Bay, Aliaska, July, 1874.

According to Dall the color of the living animal was pale yellowish-white.

The alcoholic specimens were all of nearly the same size, about 20.0 mm. long, 7-8.0 mm. broad, and 6-6.5 mm. high. The tentacles and rhinophoria measured about 2.0 mm. in length, the papillæ of the back reached 3.0 mm. in length, and the breadth of the foot 5.0 mm. The color was yellowish-white, the papillæ a little grayish, and generally with white points. The viscera were not visible through the side walls of the body.

The form of the animal was typical, somewhat depressed; the head rather large, the tentacles short and strong, stronger than the rhinophoria, the eyes not visible through the wall of the back. The foot was rather large, somewhat pointed behind, the anterior margin straight, with a very distinct transverse groove. The sides of the body rather elevated, with the genital papilla beneath the eighth and tenth row of papillæ. The back was naked in its broadest part; in the much narrower side parts covered with closely set oblique rows of papillæ, which, on the hindmost part,

cover the back entirely. The number of rows was about twenty-five to thirty-two, the foremost shorter, with about seven to nine papillæ; the hindmost the shortest, with about three to four papillæ, the rest longer and much more oblique, with about twelve to thirteen papillæ. The papillæ flattened, quite as in other true *Aeolidiæ*. The anus is between the outer part of two rows behind the middle of the back (at about the thirteenth or fifteenth row). The intestines were seen very distinctly shining through the wall of the back.

The cerebro-visceral ganglia were somewhat elongated, reniform, thinner and broader in the fore part, thicker in the hindmost part; the pedal ones rounded, triangular, as thick as the confining part of the visceral ganglia. The buccal ganglia were about one-quarter of the size of the pedal ones; the gastro-oesophageal ganglia rounded, about one-quarter of the size of the buccal ones, with three large cells.

The eye was furnished with black pigment and yellow lens. The otocysts could not be found.

The buccal tube short, rather wide, with strong longitudinal folds on the inside. The *bulbus pharyngeus* rather short, somewhat compressed; in length about 3.5 mm. by a height of 2.75, and a breadth of about 2.0 mm. The form-relations for the rest quite as in the *Aeolidia serotina* (cf. l. c.). The mandibles (fig. 1) were very strong, flattened, yellowish, or brownish-yellow; the articulation strongly developed, on the anterior outer side somewhat twisted, slightly bilobed; the keel on the inside (*crista connectiva*) short, somewhat prominent (fig. 1a); the cutting blades



The œsophagus, the stomach, the biliary ducts, and the intestine, as in other species; the stomach on each side receiving a biliary duct, and the posterior chief duct receiving from each side three strong and one to two finer ducts; the length of the intestine was about 9.0 mm., with fine longitudinal folds along the inside. The liver papillæ (in the dorsal papillæ) rather nodose. The *bursa nodifera* in the largest papillæ measured one-seventh to one-eighth of the length of the papilla, containing a mass of enidæ, elongate pyriform or staff-shaped, reaching 0.026 mm. in length (fig. 6).

The heart and renal syrx as usual.

The hermaphroditic gland is large and yellowish, of the usual structure; in the centre of the zoöspemic lobules were oögenic cells in peripheral nodosities. The anterior genital mass short and clumsy, about 5 to 6.0 mm. long by 2.5 to 3.0 mm. broad, and 2 to 4.5 mm. high. The *gl. mucosa* and *albuminifera* white and British. The *vas deferens* (fig. 5a) yellowish, very long, rolled up in a tight coil on the fore end of the genital mass; the penis (retracted) short, bag-shaped, about 2 mm. long, nearly filled by the conical glans (fig. 5), through the whole length of which the continuation of the sperm duct could be traced.

There was a peculiar aspect in the interior of this *Acolidia* (as well as in the *Ac. serotina*) as far as observations on alcoholic specimens go, which seemed to indicate a possible specific difference from the typical *Ac. papillosa*, although the anatomical examination could not bring out any very reliable specific characters.

II. CORYPHELLA, Gray

Coryphella, Gray, Figures of Moll. Anim., iv., 1850, p. 199. Gray, Guide, i., 1857, p. 224. Alder and Hanc., Monogr., Part VII., 1855, p. 49; Appendix, p. xxii. R. Bergh, Anat. Bidr. til Kundsk. om Acolid., I., 1864, p. 226. R. Bergh, Beitr. zur Kenntn. d. Acolidiaden, iii., I., c. xxv., 1875, p. 633.

Corpus elongatum. Rhinophoria simplicia. Podarium antice angulatum vel angulis productis.

Processus masticatorius *mandibular* seriebus denticulorum praeditus. Radula dentibus triseriatis; dentes laterales margine superno (interno) denticulati. Penis inermis.

The genus contains *Acoliduda* of an elongated form, with simple rhinophoria and with the anterior margin of the foot

angulated or with the angles rather produced. The edge of the cutting-blades of the mandibles with several rows of knobs or denticles. The lateral plates of the tongue have the superior (interior) margin not smooth (as in the *Galvinæ*) but denticulated. The penis is unarmed.

In my last memoir upon this genus, to which the reader is referred, I have given a list of nineteen species which seem to belong to this genus. Four of them are from the Pacific ocean.

1. *C. Foulisi* (Angas).

8. *C. parvula* (Angas).

2. *C. semilecora* (Angas).

4. *C. atkadona*, Bergh.

1. *Coryphella*, sp. Pl. I f. 13-14, Pl. II. f. 7-8.

Hab. M. Pacif. (Ins. Aleut.).

Only the *bulbus pharyngeus* of this form has been found by Dall in dredging at Adakh Island (Aleutians) in mud, at a depth of 9-16 fathoms, in June, 1873.

The length of the organ was 5.0 mm., with a height of 4.0 and a breadth of 5.0 mm.; the form short, much broader in the hindmost part; the radula sheath a little prominent behind the buccal ganglia. The labial disk of usual oval form;¹ the greatest part of the *bulbus* covered by the mandibles; the *m. trans. sup* rather large. The mandibles (fig. 7) large, nearly as long and as high as the *bulbus*, of yellow horn-color; the articulation rather small (Fig. 7a); the edges of the cutting blades with 4 to 6 (fig. 8, 13) rows of low knobs, which on the anterior margin, except in the uppermost parts of the cutting blade, rise to denticles of the height of 0.1 mm. The *tongue* rather short; on the upper side

third the size of the pedal ones, the commissure between them measuring about one-third the length of each ganglion.

III. FLABELLINA, Cuvier.

Flabellina, Cuvier, Règne An. ed. ii^a, 1830, iii. p. 55. Alder and Hancock, Mon., Part VII. p. xxi. 1835. Trinchese, Rendic. della Acad. della Sci. di Bologna, 7, 1874. R. Bergh, Beitr. zur Kenntn. d. Acolidiaden, iii., Verh. d. K. K. Zool.-bot. Ges. in Wien, xxv. p. 647, 1875.

Corpus sat elongatum, subcompressum. Rhinophoria perfoliata. Papillæ (dorsales) non caducæ, pedamentis brachioformibus insertæ. Podarium angulis tentaculatim productis.

Margo masticatorius mandibulæ seriebus denticulorum præditus. Radula triseriata, dentibus medianis denticulati, lateralibus interno margine denticulatis. Penis stylo armatus.

As for the history of the denomination of this genus the reader must be referred to my above cited paper. The *Flabellina* have nearest relation to the *Calma*,¹ but differ by the perfoliate rhinophoria and in the denticulation of the lateral teeth. They show an elongate, somewhat compressed form of the body; perfoliated rhinophoria; dorsal papillæ caducous, inserted upon arm-shaped foot-stalks the foot with produced anterior angles. The cutting edges of the jaws with rows of small denticles. The tongue with three series of teeth; the median denticulated in the usual way, the lateral ones only on the inner edge. The penis with a stylus (as in the *Calma*).

To this genus belong:—

1. *F. affinis* (Gm.), Bergh, l. c. p. 649, Taf. XV. f. 6 19; Taf. XVI. t. 3-4. M. Medit.
2. *F. flabellina* (Ver.), M. Medit.
3. *F. lunthina*, Angas, M. Pacificum.
4. *F. ornata*, Angas, M. Pacificum.
5. *F. Newcombi*, Angas, M. Pacificum.
6. *F. iodinea* (Cooper), M. Pacific. orient.
1. ~~*Flabellina*~~ *iodinea* (Cooper), Plate I. f. 15 to 17; Plate II. f. 16.
Acolis (*Philiana*?) *iodinea*, Cooper, Proc. Calif. Acad. ii. 1862, p. 203;² iii. 1863, p. 60.

¹ Cf my above cited paper, l. c. p. 643.

² "Rich, violet purple, narrow, wedge-shaped, high in front, tapering to acute point behind, slightly constricted in five parts of the body corresponding to divisions of the branchiæ. Foot very narrow, slightly expanded.

Phidiana iodinea, Cooper, Bergh, Beitr. zur Kenntn. d. Aeolidiaden, i., l. c. xxiii. p. 615,¹ 1873.

Color corporis e violaceo purpureus, rhinophoria aurantiaca, papillæ aurantiace-rubra (Cooper).

Dentes mediani sicut laterales, multidenticulati.

Hab. Ocean. pacific. orient. (San Diego, Cal. to Puget Sound.)

A single specimen was collected by Capt. Hall alive, on algæ, at low water in Puget Sound, Washington Territory, Aug. 1873. According to Cooper (l. c. p. 205) the species is found "among algæ, outside of San Diego Bay, rarely inside." According to Cooper's description and a drawing kindly lent by Dall, the color of the living animal is violet purple, the rhinophoria orange colored, the papillæ orange-red.

The length of the individual (most badly) conserved in spirits was about 15.0 mm., with a breadth of the body of 2.0, and a height of 2.5 mm.; the length of the papillæ reaching to about 4.0 mm.; the length of the tentacula about 1.5 of the rhinophoria, about 2.3 mm. The color rather dirty chocolate.

The *form* is elongated, rather compressed, the tail rather short. The head rather small, the tentacula elongate, also the apparently closely perfoliated rhinophoria. The back rather narrow; the groups of papillæ situated on the side parts of it, firmly affixed on the edge of foot-stalks, whose form and number could not be determined, owing to the state of the specimen; their number seemed to be much greater than referred to by Cooper. The foot rather narrow, the angles of the foremost margin much produced, longer than the tentacula, strong, the groove in the anterior mar-

of the specimen examined¹ did not permit the determination of the number of plates of the tongue and the posterior continuation of the radula. The *median plates* (Pl. II. fig. 16a) with a greater number of denticles, mostly with about 12-13; the lateral ones with a rather produced outer limb (fig. 16b, Pl. I. figs. 16, 17), the inner edge with a rather great number of (about 25-27) fine denticles.

As far as could be determined, a Penis-style existed, as it seemed, of about the same form as in *Fl. affinis* (cf. l. c. Pl. XVI. f. 3, 4).

IV. HERMISSENDA, Bgh.

Hermisenda, Bgh., Beitr. zur Kenntn. den Aeolidiaden, vi.; Verh. d. K. K. Zool.-bot. Ges. in Wien. xxviii. 1878, p. 573.

Corpus gracilius elongatum. Rhinophoria perfoliata, tentacula elongata. Papillae dorsales in series obliquas et transversas con-
sertas areis praesertim compluribus collatas dispositae. Pod-
rium antice angulis elongatis.

Margo masticatorius mandibulae singula serie denticulorum
praeditus. Radula dentibus uniseriatis, denticulis elongatis pra-
editis et cuspile infra serrulata. Penis inermis.

In many respects this new genus seems to agree with the *Phi-
diana*, as far as these are now known.² The general form of the
body, the rhinophoria and the tentacula are as in that genus, also
perhaps the disposition of the dorsal papillae. But the *Hermis-
enda* differ in the rather produced angles of the front of the foot,
in the form of the teeth of the tongue, but especially in the want
of a hook on the penis.

The body is rather elongated, slender. The rhinophoria are
perfoliate, the tentacula long. The dorsal papillae seems to be
arranged in oblique and transverse rows, which form several more
or less separated groups. The angles of the front of the foot are
rather elongated.

The cutting edge of the jaws has a single row of strong pointed
denticles. The teeth are in a single series; each tooth with five

¹ The individual seemed to have been found dry in the glass and put in
new alcohol in such a state. Even the outer form could not be determined
before the specimen was softened.

² R. Bergh, Neue Beitr. zur Kenntniss der Aeolidiaden. I. Verh. d. K.
K. Zool.-bot. Ges. in Wien. xxiii. 1873, pp. 613-618.

denticulations on the under side of the trigonal point and long denticles of the cutting edge at the base of the point. The penis is unarmed.

Only one species of the group is hitherto known.

1. *Hermisenda opalescens* (Cooper). Plate I. fig. 9; Pl. II. f. 1-6.

Aeolis (*Flabellina*?) *opalescens*, Cooper, Proc. Cal. Acad. ii. 1862, p. 203, iii. p. 60, 1863.

Hermisenda opalescens, Bergh, l. c.

Color corporis e caerulescente albescens, pellucidus; rhinophoria opalina, nucha stria longitudinali aurantiaca; papillae lutescentes, apice purpurascenti.

Hab. San Diego Bay, Cal. to Sitka, Alaska Territory.

Of this species Dall found two living specimens at Sitka, on algae at a depth of 6-10 fathoms, Aug. 18th, 1865.

Cooper saw "this elegant species" numerous in the San Diego Bay in the winter, living among the (sea) grass and "depositing its ova on any fixed object it meets with."

According to Cooper's description and drawings kindly lent me by Dall the living animal is nearly transparent, bluish-white, the rhinophoria of opaline color, with an orange stripe between them; the papillae of yellowish color with a purple or blood-red spot near the end. Dall regards the animals, found by him, as identical with the species of Cooper,¹ although the colors according to some (4) colored sketches of Dall are rather different from those mentioned by Cooper. For these sketches the color is grass-green, much paler on the under side (foot), the rhinophoria whitish, the liver lobes purple-red shining through the papillae.

on the lateral part of the back along the papillæ yellow vessels (hepatic ducts?) shining through the walls of the back. According to Cooper the *length* of the living animal reaches about one and a half inch. Dall's specimens were only about seven lines in length.

The length of the individuals preserved in spirits was about 12.5-13.0 mm. by a breadth of 4-4.5, and a height of 3-4.25 mm.; the length of the tentacula was about 2.5-3.0, of the rhinophoria 2.5 mm., that of the papillæ reaching 4.0 mm.; the breadth of the front part of the foot 4.0 mm.; the length of the produced angles about 2 mm. The color was uniformly brownish-white; the intestines nowhere shining through the skin.

The head is rather large, the tentacles long and strong, the oral aperture as usual; the rhinophoria are strong, the club with about twenty to twenty-five leaves. The back is rather broad; the papillæ set in transverse or oblique rows, that were crowded in about four groups. The *first* group of papillæ is the largest of all, compressed—horse-shoe shaped, with about five to seven oblique rows in the foremost and four to five in the hindmost limb; the number of papillæ in the rows seemed not to surpass ten or twelve. The *second* group had about six to seven oblique rows; the number of papillæ in the rows seemed not to exceed eight or nine. The space between the first and second groups was larger than that between the second and third, in the uppermost part of the latter space is the rather prominent, goblet-formed or more appanate anal papillæ; more forward and downward was the renal pore, which in one individual was rather prominent. The *third* group on one (right) side composed of several (five to seven), on the other of fewer (three to four) rows, but never very distinct from the *fourth* group, which had about ten to fourteen densely set rows, which by degrees decrease in size backwards and cover the whole of the rest of the side parts of the back; sometimes the rows of this fourth group stand in pairs; the innermost parts of the rows are separated by very narrow spaces.¹ The papillæ conical, somewhat contracted in the inferior parts. The sides not low; the genital papillæ in the usual

¹ The state of conservation of the individuals did not permit me to ascertain the relations of the groups and the rows with full certainty, so much the more as the greater part of the papillæ had dropped off.

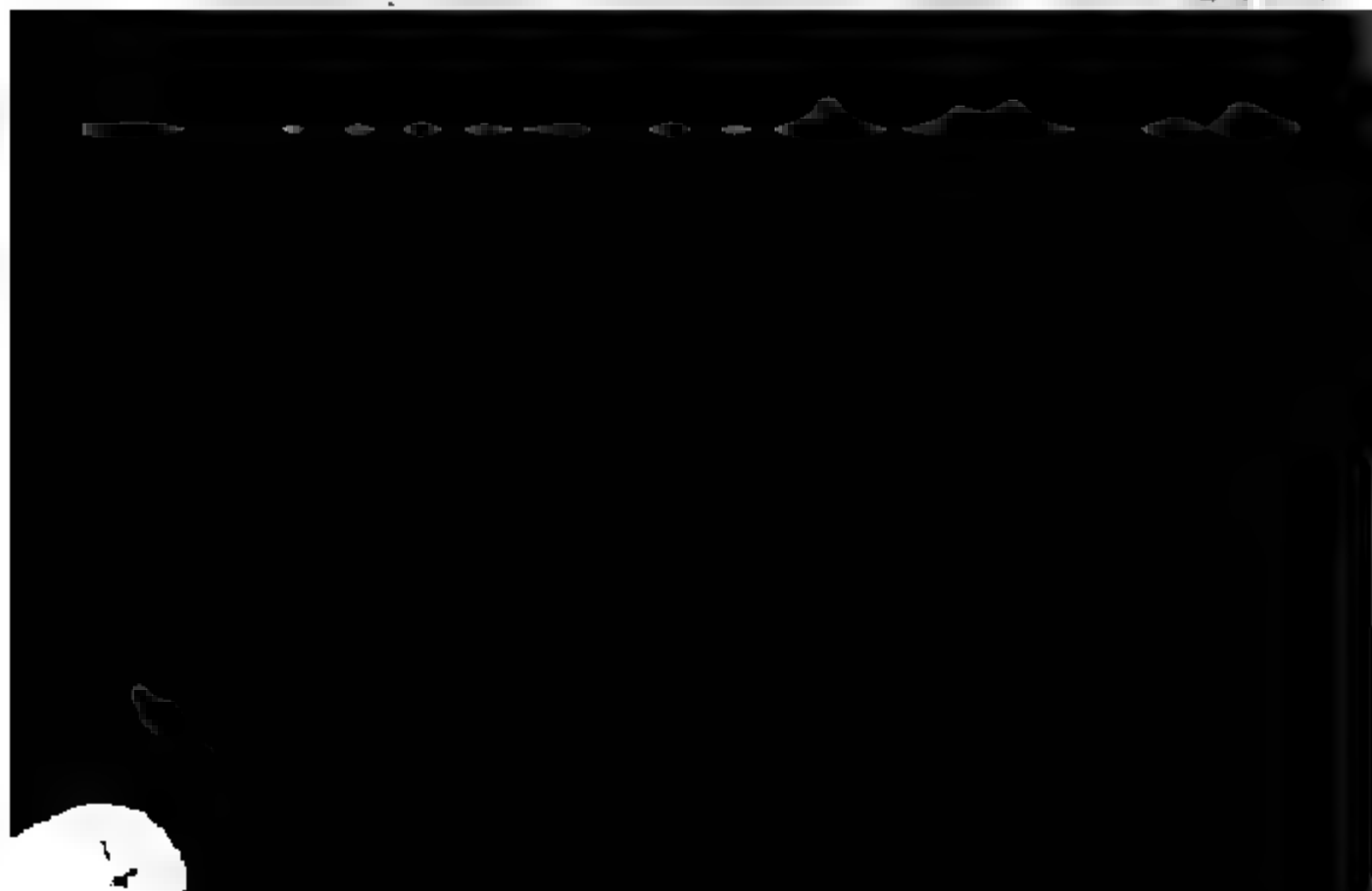
place (under the region between the two extremities of the first group of papillæ), contracted. The foot is strong; broader than the back, the muzzle rather broad and produced into angles anteriorly; their length about one-third of the breadth of the foot; the groove of the anterior margin is continued along the margin of the angles, the tail measuring about a third of the whole length of the foot.

The cerebro-visceral ganglia are rather short, not much larger than the short pyriform pedal ganglia.

The buccal ganglia are rounded, connected by a commissure which is a little longer than the diameter of the ganglia. The gastro-oesophageal ganglia are not long-stalked and have about 0.18 of the size of the last mentioned, with one large and two rather large cells.

The eye has black pigment and yellowish lens. Immediately behind the eye is the otocyst, scarcely larger than the eye, with thirty-five to forty-five otoconia of the usual form. The rhinophoria are as in related forms of *Aeolidiidae*.

The bulbus pharyngeus is shaped as usual, and is from 2.75 mm. to 4.5 mm. in length. The jaws (fig. 9), as commonly among the *Phidiana* are yellowish-horn colored. The articulation (fig. 9a) is rather small; the cutting blades arched (fig. 9b) their edges with a series of about fifty strong, sharp pointed denticles (fig. 10), the uppermost short (fig. 10a), by degrees increasing in size to about the length of 0.06 mm.; the hindmost are serrulate (fig. 10b) on the posterior margin. The accessory buccal cavity behind the articulation of the jaw rather large, and



The intestines are rather short, with a strong longitudinal fold through its first half, with many fine longitudinal folds in the anal papillæ. In the digestive channel were stems of Hydroidæ and different forms of Diatomacæ.

The liver papillæ have a rather smooth surface. The *bursæ cnidophoræ* rather short, pyriform, with masses of small cnidæ (fig. 12), partly of oval form and generally measuring in length about 0.013 mm., partly shorter, staff-shaped, and rarely surpassing the length of about 0.01-0.07 mm.

The hermaphroditic gland is very large, the lobes and lobules as usual; in the centre of the last were zoosperms; in the peripheric (fig. 5) acini (which in very different numbers cover the central part) were oögene cells. The anterior genital mass was large, 2.2 to 4 mm., with a breadth of 1.2 to 2.75, and a height of 1.2 to 3 mm.; the whole, in great part formed by the *gland. mucosa et albuminosa*.

The *Spermatotheca* seemed rather peculiar; it was sac-shaped, rather short, and short-stalked; the free end of the *vas deferens* was only two or three times as long as the penis, somewhat thicker in the middle, strong, continued (fig. 6a) through the whole length of the penis. The retracted *glans penis* in its sheath (fig. 6bb) which had a length of about 3.5 mm., as also the glans, which was strong, short, sausage-shaped, with a round opening at the end (fig. 6c). A layer of rather short sacculate glands filled the end of the penis around the orifice. One of the drawings represents the spawn of *Ae. opalescens* as a rather long corkscrew-shaped coil of reddish hue.

V. FIONA, Hanc. et Embleton.

Fiona, H. et E. Forbes and Hanley, Brit. Moll., iii. 1853, p. x. Ald. and Hanc., Monogr. Brit. Nudibr. Moll., Part VII., 1855, pp. 52, 53, fam. 3. Pl. 38a. R. Bergh, anatom. Unders. af *Fiona atlant.* Vidsk. Meddel. fra naturh. Foren, i Kjobenhavn for 1857, pp. 273-337 (279-283 !), 1858, Tab. II. III. R. Bergh, Contrib. to a Monogr. of the Gen. *Fiona*, H., 2 w. pl. Copenhagen, 1859. R. Bergh, Journ. d. Mus. Godef. 2te Heft, 1873, pp. 80-88, Tab. XII. fig. 4, 5. R. Bergh, Beitr. zur Kenntn. der Acolidiaden, I; Verh. d. K. K. Zool.-bot. Ges. in Wien, xxiii. 1873, pp. 605-610. V, l. c., xxvii. 1877, pp. 823-824.

Hymenaeolia, F. Costa, Annuario del Mus. zool. di Napoli, lil., 1866, pp. 64, 80; iv. 1867, p. 28.

Rhinophoria et tentacula subsimilia, simplicia. Papillæ (dorsales) cuti firmiss affixæ, elongatæ, ab membranam branchialem

quasi alatæ, bursa cnidophora nulla. Anus dorsalis dextrorsum, apertura genitalis gemina. Mandibulæ cymbiolatæ, processu masticatorio brevior subhamato, margine masticatorio sat grosse denticulato. Lingua elongata, compressa, serie dentium unica; dentes arcuati, cruribus angustis, acie cuspidè prominulo et utrinque denticulis compluribus.

For the general characters of the genus the reader is referred to my monograph (1857) and to the above cited publications (1873).

The animals are pelagic, but few species are yet known, which besides are not well distinguished, and may perhaps prove to belong to one circumæquatorial and cosmopolitan form.

They are:—

1. *F. marina* (Försk.) M. Atlant. mediterr.
2. *F. pinnata* (Eschsch.) M. Pacific. sept.
Bergh, l. c. xxiii. p. 606, 1878.
3. *F. longicauda* (Quoy and Galm.) M. Pacificum.
4. *F. ? alba* (Van Hasselt) M. Indicum.

I. *Fiona marina* (Försk.), var. *pacifica* Bergh. Plate I. fig. 7-8.

Limax marina, Förskal.

Fiona nobilis, Hancock and Embleton, l. c.

Fiona atlantica, Bergh, l. c.

Hymenaeolis elegantissima, A. Costa, l. c.

Color caeruleo-purpureus (Dall).

Hab. Oc. Pacificum, Atlanticum, Mediterraneum.

A single individual of this species was taken by Dall in 1873,

what flattened. The rhinophoria are smooth, scarcely longer than the tentacles. The eyes are not visible externally. The back throughout its whole length naked on the broader middle part; laterally closely set with oblique rows of papillæ,¹ about seven to eight in each row, fewer in the fore and hindmost rows; the papillæ conical, somewhat compressed, particularly in the inferior parts, with the usual gill-membrane along the inner edge.² The anus in the usual place. The sides of the body rather high, the genital openings quite contracted. The foot in the foremost part rather broad, anteriorly rounded; backwards gradually narrower, the margins projecting a little from the sides; the tail rather short (about 1.5 mm. long), merely projecting a little behind the body.

The central nervous system is of the usual form,³ rather flattened; the cerebro-visceral ganglia rounded, triangular, the pedal ones a little larger, of oval form, the buccal and gastro-oesophageal ganglia as usual.

The eye is as usual, with black pigment, and with a rather large lens. The otocysts could not be detected.

The oral tube (retracted) about 1.5 mm. long, rather wide. The oral glands⁴ long as usual, opening in the oral tube; whitish. The *Bulbus pharyngeus* 3.0 mm. long, with a breadth of about 1.8 mm., as formerly described.⁵ The mandibles also quite as in the typical form.⁶ The tongue long and narrow, as in the last;⁷ on the under side twelve, on the end two, and on the upper side twelve teeth; also in the sheath of the radula eleven developed teeth and two not fully developed plates; the number of teeth was consequently thirty-nine.⁸ The form of the teeth (fig. 7, 8) was as usual; on

¹ Cf. l. c., 1858, Tab. I. f. 1-3.

² Cf. l. c., 1858, Tab. I. fig. 4-5.

³ Cf. l. c., Tab. I. fig. 7.

⁴ These glands, which have been formerly described by me as salivary, cannot be so homologized, because their ducts do not pass over the commissures of the central nervous system. Glands of the same kind have been found in other forms of *Acolidiidae*, in the genus *Acolidiella*, Bgh. (Cf. my Beitr. zur Kenntn. d. Mollusken des Sargassomeeres. Verh. d. k. k. Zool. bot. Ges. in Wien, xxi. 1871, Taf. XIII. fig. 20b, and Beitr. zur Kenntn. d. Acolidiaden, ii. l. c. xxiv. 1874, p. 399, Taf. VIII. fig. 11bb).

⁵ Cf. l. c., Tab. I. fig. 8.

⁶ Cf. l. c., Tab. I. fig. 9-13.

⁷ Cf. l. c., Tab. I. fig. 16-18.

⁸ Cf. l. c., Tab. I. fig. 23-28. The author found in twenty-two specimens of the *P. atlantica* thirty-eight to fifty teeth; the number of denticles was mostly six to eight, sometimes eleven to twelve, on each side; later (Beitr.

the cutting edge were on each side seven to nine denticles; on the foremost teeth often nine; the breadth of the foremost teeth was about 0.13, of the twelfth 0.18 mm., the width amounting to 0.37 mm. or less.

True salivary glands do not exist. The œsophagus, the stomach, the intestine and the hepatic system, as far as could be determined, were quite as in the typical form.¹

The vascular system and the renal organ are as formerly described by me.²

The hermaphroditic gland³ is quite as in the typical form, also the hermaphroditic duct with its ampulla, and the spermato-duct with its two parts, one thicker and brownish, the other thinner and whitish. So also is the long (about 7 mm.) whip-like penis, which is drawn back and bent up and down in the thinner sheath-like part. The latter showed rather strong, circular, muscular belts, and had a *M. retractoris* attached near the neck; the continuation of the spermato-duct could be followed through the whole length of the penis to its point. The *spermatheca* forms a short bag about 1.-3.0 mm. long, filled with sperma. The anterior genital mass is rather compressed, and about 4.25 mm. in length.

DENDRONOTIDÆ.

The *Dendronotidæ* form, like the *Scyllæidæ* and *Bornelliæ*,⁴ in certain respects a connecting link between the large group of *Æolidiïdæ* and the still larger group of *Dorididæ*. In those families the liver forms, as in the *Dorididæ*, a large compact mass,



The *Dendronotidæ* differ externally very distinctly from the *Ullæidæ* and *Bornellidæ*, especially in the form of the dorsal villæ; in the anatomical relations of the form of the mandible and by the character of the *gl. hermaphrodisiaca*, which is (as in the *Dorididæ*) separate from, but connected with the *r.*

Only two generic forms of the family have hitherto been known.

1. *Dendronotus*, A. and H.

2. *Campaspe*, Bgh. Naturhist. Tidssk., 3 R. J., 1863, pp. 471-478, Tab. XII. figs. 1-17.

DENDRONOTUS, A. and H.

The true *Dendronoti* differ from the *Campaspæ* by the much more composite form of the frontal appendices, of the appendices the margin of the sheath of rhinophoria, and of the dorsal villæ. The lateral teeth of the tongue of the former especially longer than in the *Campaspæ*.

Only a few species of the genus are hitherto known.

D. arborescens (O. F. Müller). M. Atlant.

D. luteolus, Lafont, Act. Soc. Linn. de Bord. 28, 1872. M. Atlant.

D. robustus, Verrill, Amer. Journ. of Sci. and Arts, n. s. L., 1870, p. 405. M. Pacif.

D. iris., Cooper, Proc. of the Cal. Acad. of Sciences, ii. 1862, p. 59, 1868. M. Pacif.

D. purpureus, Bgh. n. sp. M. Pacif.

Dendronotus purpureus, Bergh, n. sp. Plate I. fig. 18-20; Plate III. fig. 7-12.

Color purpureus.

Dentes medianæ (linguales) minutissime serrulati altamen non que ad apicem.

Hab. M. Beringianum (Port Möller, Aliaska Peninsula).

Only one specimen of this species was taken by Dall at Port Möller on the north shore of Aliaska Pen., in September, 1874, at a depth of seventeen fathoms, sand. He notes only that the animal when living had the "mantle purple."

The color of the alcoholic specimen, which was not in the best condition, was reddish-brown, the head and foot yellowish. The length of the (partly mutilated) animal was apparently about 20.0 mm. when perfect, with a height of the body of about 6.5 and a breadth of nearly 5.0 mm. The height of the dorsal papillæ reached 3.0 mm. the breadth of the foot 3.5 mm.

The form resembled that of the typical species, the veil had two median arbusculi, and on each side three lateral ones, the median little larger than the laterals; between the median a small, simple, rather prominent papilla. A similar papilla seemed to exist between the two lateral arbusculi. Under the veil, on the upper lips of the simple muzzle were a series of small, simple, truncate papillæ; the most lateral one larger (representing the tentacle??).¹ The sheath of the rhinophoria high; above this was the usual larger branched appendage, divided at the top into five nearly similar appendages; the club not large, with about twenty rather thin, and very broad leaves (on each side) mostly alternating in breadth.² The body of the typical form had the arborescent papillæ, as in the typical species; the two foremost pairs seemed more branched and more divaricate, between them (in the region of the heart) lower arborescent tufts.³ Between the first and second papillæ of the right side was the large truncate anal prominence,⁴ and at its root in front the very fine renal pore. The sides of the body were rather high; the genital opening in the usual place in front of the region of the first (dorsal) papilla, with two fine apertures. The foot was rather narrow, scarcely divided from the sides of the body; the front end rounded, a groove between this and the under part of the mantle.

The cerebro-visceral ganglia were nearly as figured by Alder and Hancock (l. c., fig. 9), the cerebral part a little larger than the visceral; the pedal ganglia more rounded, and the commissure between them longer. The olfactory ganglia in the root of the club of the rhinophoria were nearly spherical, rather large. The



a little shorter than the longest diameter of the ganglia; the *ganglia gastro-esophagalia* in size were about one-eighth of the last, rounded, with a very large cell and several smaller ones. The commissures, as in the *D. arborescens*.¹

The eye was as usual, the pigment black.² The *otocyst* of the diameter of about 0.1 mm., crowded with otoconia of very (from about 0.004–0.0255 mm.) varying size. The leaves of the club of the rhinophoria without spicula, and also the skin of the body, which is easily detached from the subcutaneous muscular layer; on the dorsal papillae especially, were masses of small yellowish sac-shaped glands containing fatty matter. The anal tube was short and wide, with longitudinal folds; the *bulbus pharyngeus* formed as in the typical species, 5.0 mm. long, 3.0 high, and 3.0 mm. broad. The insertion of the esophagus was before the middle of the upper side. The labial disk or ring strong, radiately furrowed, of deep brown color internally; this inner portion formed a narrow prehensile collar, composed of rather irregular closely and obliquely set erect (fig. 18–20) spines, somewhat like those of the labial plates in so many *Dorididae*, of dirty light yellowish-brown color,³ and about 4. mm. in height.

The mandibles were yellowish-horn color, except that the articulation was very dark-brown; the form was exactly as in the typical and in the following species (cf. Pl. III. fig. 2–3).

The *processus masticatorius* was rather short (fig. 7a), with a single series of small denticles exactly as in the *D. arborescens* (Pl. II. fig. 13; Pl. IV. fig. 1); the cavities behind the articulation of the mandibles were rather large (Pl. III. fig. 3). The tongue exactly as in the typical and in the next species (cf. Pl. II. fig. 9, 10); the *lectum* (fig. 9a) *radulae* much extended forwards, and the superior (fig. 10a) part of the rasp therefore very short; the

The visceral commissure has not hitherto been seen even by Ihering (i. c., p. 176); it is the foremost of the commissures, rather thin, the *N. genitalis* very distinct.

¹ In the *Dendron. arborescens* the end of the *n. opticus* is sometimes black.

² A similar somewhat broader collar was found in the larger specimens of *D. arborescens*, but whitish like the rest of the labial disk, the spines (Pl. IV. fig. 2) were in more numerous rows (they hardly exceeded twenty in *D. purpurus*), and were light yellowish and longer. In two smaller individuals no trace of the collar could be found.

³ Cf. my above cited paper, Tab. XII. fig. 28–30.

rasp-sheath very obliquely descending between the muscular masses of the tongue, and appearing on the lowest part of the back side of the *bulbus pharyngeus* (fig. 10c). The rachis (fig. 9b) with nineteen rows of teeth on the anterior margin, and with one on the superior; besides three loose median teeth laying in the pocket on the inferior end of the tongue; in the sheath twenty-two developed rows and two undeveloped, the total number of rows was thus forty-four. The color of the median teeth horn-yellow, that of the lateral much brighter yellowish; the breadth of the eldest median teeth about 0.16 mm., of the eighth about 0.18, and of the latest developed 0.20 mm. The form of the teeth exactly as in the *D. arborescens* (cf. Pl. II. fig. 14). The median ones (fig. 8-10) with a very fine denticulation on the margin, much finer than in the typical species, and not reaching so far (cf. Pl. II. fig. 14, and Pl. III. fig. 10) out toward the point. The lateral plates number also about fourteen, of typical form; the first sometimes with traces of a slight serrulation on the inside of the hook, the following mostly with about five to six (sometimes even seven to nine) sharp denticles on the outside (fig. 11); in the three to four (rarely five) external plates the free hook disappearing more and more together with the denticles; the outermost, or the two outermost, were very thin¹ (Pl. III. fig. 5). Variations in the form of the lateral teeth, and coalescence of two teeth were often observed, quite as in the typical species (cf. Pl. III. fig. 1a).

¹ According to Alder and Hancock (l. c.) the number of rows of teeth in the *D. arborescens* is about forty, with nine lateral teeth on each side. Meyer and Moebius mention (l. c. p. 44) a "Radula," with forty-four rows, by which is probably meant the total number of rows on the rachis and in the sheath), and with ten lateral teeth, and the same number of lateral teeth has been indicated by Loven. In my former examination (of two individuals) I saw sixteen to twenty-two rows on the rachis and twenty-five to twenty-seven in the sheath, or a total number of forty-one to forty-nine rows, with ten to thirteen lateral teeth. In my present examination of five specimens of *D. arborescens* (like the former, all from the Greenland coast at Jacobshavn, etc.) I find the number of rows on the rachis varying in small individuals from thirteen to eighteen, and those in the sheath from sixteen to twenty-three, the total number thus varying between twenty-nine and forty-one, in three large individuals, having a length of 35.0 mm., the number was 13 + 20 (33), 16 + 20 (36), and 22 + 26 (48), the number of lateral teeth being eleven in the former and thirteen in the latter. In all specimens two or three median teeth were found loose at the under side of the root of the tongue.

The salivary glands were very long, accompanying the œsophagus (cf. Pl. III. fig. 12a) and extending further backwards; the duct was also rather long (fig. 12b).

The œsophagus, stomach, and intestine were as in the typical species. The liver, perhaps in consequence of occasional contraction of the animal, much thinner anteriorly, much thicker posteriorly, and of a more grayish color.

The heart was as usual. The renal syrx nearly equalled the ventricle of the heart in size. The renal organ, as far as could be determined, was as in the *Aeolidiidae*. The hermaphroditic gland almost as in the typical species¹ covering the back of the liver from the anterior end of this organ (or nearly reaching the anterior genital mass) to a point between the last pair of branches for the dorsal papillæ. The gland forms a rather thick layer, which is a little narrower than the liver, and fills the longitudinal median groove in the upper side of it. It is of a slate gray color, owing to the peculiar pigment of the single glands; is composed of a mass of rather large, rounded, isolated, but (from reciprocal pressure) often subangulated glands (cf. Pl. II. fig. 15).

Neither developed zoöspores nor large oogene cells were found in the glands of the individual examined. The anterior genital mass was whitish and yellowish: and, as far as could be determined, quite as in the *Dendr. arborescens*: a very large part of the whole mass was formed by the long penis, which still seemed somewhat shorter than it usually is² in the typical species (cf. Pl. IV. fig. 4).

This form might, perhaps, prove to be identical with the form of *Dendronotus* "with the tips of the branchial tufts white," fished by Couthouy (U. S. Explor. Exped. Moll., 1852, p. 311), in Puget Sound; or even to agree with the *D. iris* of Cooper (l. c.). Under the circumstances, the form described above must very likely be regarded as a new species, not even identical with the nearly red *Tritonia pulchella* of A. and H. (Ann. Mag. Nat. Hist. 5 v. 1842, p. 33), which, like all the forms of *D. arborescens* is still dotted with yellow (cf. A. and H., Monogr., Part I., 1845, fam. 3,

¹ The representation by Alder and Hancock (l. c., Pl. II. fig. 1j) is incorrect.

² The penis seems to vary a good deal in the *Dendron. arborescens*, or at least to be very contractile.

pl. 3). Besides the color the form clearly differs in the *very weak serrulation of the median teeth*.

Dendronotus Dallii, Bergh, n. sp. Plate I. f. 21; Pl. II. f. 9-12; Pl. III. fig. 2-6.

Animal?

Dentes mediani margine laevigato.

Hab. Fretum Beringianum.

In dredging on rocky bottom at a depth of thirty-five fathoms in the Arctic Ocean, Bering Strait, August, 1855, Dr. Wm. Stimpson obtained the *bulbus pharyngeus* of a mollusk, which proves to be a *Dendronotus*.

The size of the bulbus was uncommonly large, the length being about 10.5, the breadth 7.0, and the height about 6.0 mm. Its form and that of the mandibles (fig. 2-4) resembled that of the same parts in *D. arborescens* and *D. purpureus*, but of somewhat darker color, the edge of the cutting blade (fig. 2c, 3c, 4) differing a little from that of the other species, and the serrulation of the denticles being more distinct than in them. The tongue (Pl. II. fig. 9, 10) as in the other species. There were on the rhachis twenty-four rows of teeth, in the sheath twenty-five developed and two not quite developed rows, the total number of rows amounting to fifty-one. The median teeth were of very dark, nearly black-brown color, reaching a breadth of 0.3 mm., without any trace of serrulation of the margin (fig. 11, 12b). The lateral teeth (fig. 5) number fourteen, rarely fifteen, quite as in the other species, the four to five outermost also without denticulations (fig. 21a, fig. 5a).

The bulbus clearly belonged to a *Dendronotus* different from the



TRITONIIDÆ.

The genus *Tritonia* was established by Cuvier as early as 1798, but may have been at first¹ hardly separable from the forms subsequently named *Dendronotus*, A and H.

Cuvier gave no type of the genus. Lamareck soon afterward (1801) adopted the name of Cuvier,² but used as example the *Aporis clavigera* of Müller, which has since become the type of the genus *Triopa*. Thus the genus must really take date from the later anatomical publication of Cuvier in 1802.³ The genus is not properly characterized here, and contains the *D. clavigera* (= *Triopa*), the *D. cervina* (= *Dendronotus*), the *D. coronata* (= *Dodo*), the *D. arborescens* (= *Dendronotus*), and the *D. frondosa* (= *Tritonia Hombergi*), besides a form which Cuvier regarded as probably new, the *Tritonia Hombergi*, which he seems to establish as the type of the genus, especially in the first edition of the *Regne Animale*,⁴ and this has since been regarded as the typical form by all later authors.

Except that some new species of the genus were described, nearly nothing since Cuvier was known of these animals until the anatomical examination of the *Trit. tethyden*, by Delle Chiaje, 1824,⁵ and especially until the excellent publications of Alder and Hancock in 1855.⁶

The genus has by different authors been classed with other genera in different ways; as a family *Tritoniacea* (Menke, Philippi, Forbes, and Loven); *Tritonia* (Fér., Rang); *Tritoniada* (Johnston); *Tritoniada* (d'Orb.); but all the arrangements have been quite unnatural. Alder and Hancock first (1855) formed a natural group of *Tritoniada*,⁷ only including the genus *Tritonia*, and this family was soon after (1857) adopted by Gray.⁸

¹ Tabl. Élém. an vi (1798), p. 387. "Le nombre des tentacules qui entourent la bouche varie de deux à huit." Cuvier, l. c.

² Lamareck, Syst. des animaux sans vert. an ix (1801), p. 65.

³ Cuvier, Mém. sur le genre *Tritonia*, Ann. du Museum, 1, 1802, pp. 480-496, Pl. XXXI-XXXII.

⁴ Cuvier, Règne Animale, ii. p. 391, 1817.

⁵ Delle Chiaje, Mem. sulle storia degli an. s. vert. iv. 1829. Tav. lxii. ed. 2. V. p. 74.

⁶ Alder and Hanc., Monogr. of the Brit. Nudibr. Moll., Part VII. 1855. Cam. 2, Pl. I-II.

⁷ Alder and Hanc., l. c. Part VII. 1855, app. p. xx.

⁸ Gray's Guide, i. 1857, p. 218.

The characters of the family seem at present to be formulable in the following way:—

Corpus subquadrilaterale, subelongatum. *Velum frontale* sat magnum, integrum vel sub-bilobum, margine laciniis tentacularibus fimbriatum. *Rhinophoria* vagina tubulosa, erecta, margine revoluto retractilia; petiolo cylindrico; clavo culmine obtuso obliquo margine pennis bipinnatis instructo. *Branchiæ* numerosæ, subpedicellatæ, arbusculi-formes, inæquales, margine palliali prominulo serie simplici dispositæ. Anus lateralis.

Bulbus pharyngeus magnus. *Mandibulæ* fortes, plus minusve elongatæ, sat applanatæ. *Radula* lata, multiseriata. Series dentium multidentatæ, dens medianus latus, depressus vel nonnihil elongatus, subpyramidalis; utrinque dens lateralis mediano subsimilis, sed magis elongatus; dentes exteriores hamiformes, margine lævi vel denticulato.

Hepar non ramificatum. Spermatotheca unica. Penis elongatus, inermis.

The body of the *Tritoniidæ* is rather stout and strong, somewhat elongated, subquadrilateral. A large frontal veil covers the head; it is simple or more or less bilobed, the margin with more or less numerous, rather short, digitations. The sheaths of the *rhinophoria* erect, tubulous, with revoluted margin; their stalks cylindrical, the club oblique above, with bipinnate plumes on the margin. The gills are rather numerous, unequal, subpetiolate arborescent, inserted one behind the other upon the somewhat prominent pallial margin. The anus is before the middle of the

of *Nudibranchiata* with a ramified liver, and those with a simple liver embracing the *Dorididæ* and the *Porostomata*¹ (*Doriopsidæ*, *Phyllidiidæ*).

As in the *Dorididæ* there is only one *spermatotheca*; but in the general form of the body, and in the nature of the pharyngeal bulbous they show more affinity to the *Porostomata*.

The family seems to include but one genus, the proper *Tritoniæ*; two other established genera, the *Candiella* of Gray (Fig. Moll. An. iv. 1850, p. 106), with *Tr. plebeia* as type, and the *Nemopcephala* of A. Costa (Atti della R. Acad. delle Sci. di Napoli, iii. No. 19, 1869) with the new (?) species (*N. marmorata*, C.) as type—very likely merge in the typical genus, at least the characters given by these authors do not raise these forms to new generic rank.

The animals belonging to this group are all slow, sluggish, and voracious. The spawn of the northern European species has been made known by Dalzell, Alder, and Hancock; of the developmental history nothing is hitherto known.

This group seems not to belong to the tropical seas. A small series of species has been published from the eastern part of the Atlantic (while only one is yet known (?) from the western), from the Mediterranean, the Red Sea, and the northern part of the Pacific.

1. *Tritonia Honbergi*, Cuv. N. Atlant.

2. *Tr. rubra*, Leuck. Rupp. Atlas, 1828, p. 15, t. 4, fig. 1.

3. *Tr. elegans*, Sav. Égypte, xxii. Pl. II. fig. 1, 1827.

Tr. glaucæ, Leuck. Rupp. Atl., p. 16, t. 4, fig. 2, 1828. Mare Rubrum.

4. *Tr. cyanobranchiata*, Leuck. Rupp., l. c., p. 16, t. 4, fig. 3 a, b, Mare Rubrum.

5. *Tr. decaphylla*, Cantr. Bull. de l'Ac. des Sci. de Brux. 11, p. 384, 1835.

Tr. quadrilatera Schultz, Phil. En. Moll. Soc., i. p. 103, t. xix. fig. 2; ii. p. 76.

? *Tr. Blainvillæ*, Risso, Eur. Mérid. iv. p. 35, 1826. Verany, Journ. de Conchyl. iv. p. 386, 1853¹ (unpublished).

? (Juven.) *Tr. gibbosa*, Risso, l. c. p. 35. Mare Méditerran.

¹ I have used this name for a group including the *Doriopsidæ* and *Phyllidiidæ*; cf. my Mal. Untera. x. 1876.

² The species is named, but not described. The cited book of Verany has never been published. Last year a young friend, M. Vayssièrre, of Marcellles got some specimens from the family and kindly sent me one. Cf. my Mal. Untera., xiii. 1878, p. 530.

6. *Tr. tethydea*, Delle Chiaje, Mem. iv. 1829, t. 2, fig. 20, Ed. 2, v. p. 74.
Mare Mediterran.
7. *Tr. Oostæ*, Verany, Catal. p. 23, t. ii. fig. 7, 8, 1846. Mare Mediterran.
8. *Tr. Meyeri*, Verany, Zool. des Alpes Marit. p. 871, 1862. Mare Medi-
terran.
9. *Tr. acuminata*, O. G. Costa, Statistica fis. ed econ. dell'isola di Capri,
ii. 1, 1840, p. 1840, p. 69, Tav. V. fig. 1 a, b.¹ Mare Mediterran.
10. *Tr. tetraquetra* (Pallas). Mare Pacificum.
11. *Tr. Palmari*, Cooper, Proc. Cal. Acad. Sci., ii. 1863, p. 207. Mare
Pacificum (Cal.).
12. *Tr. Hawaiensis*, Pease, Proc. Zool. Soc., xviii. 1860, p. 33. Mare
Pacificum.
13. *Tr. pallida*, Stimpson, Proc. Phil. Acad. Nat. Sci., vii. p. 388, 1856.
Mare Capense.
14. *Tr. cucullata*, Gould, Expl. Exp. Shells, 1852, p. 308. Mare Atlant.
occid. (Brasilia).
15. *Tr. plebeia*, Johnst. Mare Atlant.
16. *Tr. lineata*, Alder and Hancock. Mare Atlant.
17. *Tr. (Duvancella) gracilis*, Risso, l. c. p. 38. Mare Mediterran.
18. *Tr. manicata*, Desh., Tr. de Conchyl. 1839-1853, expl. des pl. p. 59,
pl. 93, fig. 2.
? *Nemiocephala marmorata*, A. Costa, Illustr. di due generi di Moll.
Nudibr., Atti. della R. Ac. Sci. di Napoli, iii. No. 19, 1860, Tav.
—, fig. 6-8. Mare Mediterran.

I. *Tritonia tetraquetra* (Pallas), Pl. III. f. 13-16; Pl. IV. fig. 5-12; Pl. V. fig. 1-2.
Limax tetraquetra, Pallas, Nova Acta Petrop. ii. p. 237, 239, Tab. V. f. 23,
1788

Doris tetraquetra, Gmelin, S. N. ed. xiii. t. 6, p. 3106, 1760.

Color animalis cinerascens.

Hab. M. P. occidentale (Insule Kurile, Aleutiane)



remarking that they are found larger than the figure he gives, which has a length of seven to eight centimetres.

Of this curious form only one specimen was found by Dall at Unalaska, on a reef at low water (in April, 1872). The color of the *living animal* is noted as having been "ashy gray."

The color of the animal, *preserved in spirits*, was uniformly light gray-yellowish; on the pinnae of the plumes of the rhinophoria, but especially on the envelope of the papillae of the club of these, were remains of a silverish-white, which is also seen on the lobes of the anus and the renal orifice. The length of the body was about 75.0 by a breadth of 37.5, and a height of 26.0 mm. In general the form of the animal was somewhat as in the typical *Tritonia*, rather stout; the anterior part of the body hardly narrower than the median, the posterior somewhat constricted. The back was a little convex, sloping backwards, rather smooth or very minutely granulated, feeling a little rough to the touch; on the edge finely tuberculated.¹ The edge projecting about 6 mm.; thinner towards the border, which is finely and irregularly toothed, but showed (Pl. III. fig. 14) few traces of gills;² on the left side the margin is continued to the (left) rhinophorium, on the right it did not reach quite to the region of the genital openings; backwards it grew narrower and thinner, over the tail it was nearly 2 mm. broad. The *rhinophoria* are rather distant from each other, almost entirely as in the *Tr. Hombergi*; the apertures of the prominent sheaths oval, with a diameter of about 6 mm., with the border undulated, and involuted. The stalk of the club low; the club itself cylindrical, about 3.75–4.0 mm. high; the central part of the club much lower, oblique; in the periphery the club is divided in several (about ten) larger, commonly bi- or tripinnate plumes, which sometimes are again divided into a medial with a lateral one on each side; between these stand sometimes one or two smaller and single plumes; the foremost is the lowest; the hindmost of all the plumes is the largest, and the stem of this is produced in a thick papilla projecting over all the plumes; from

¹ Pallas mentions the back as more unequal ("grandinoso-inequale").

² Very likely the gills were rubbed off; on the other hand, Pallas, too, does not mention nor in his figure represent gills, he only says that the back side has "anguli carunculato hiulei." (The animal when fresh showed no traces of any gills to the casual observer, and had not been subjected to rough handling.—DALL.)

the base of this papilla three to five low septula diverge, divide and go to the base of the plumes and their broad rhachides.¹ The veil entire (not bilobed); with the upper border (about 8 mm.) and the corners (about 10 mm.) freely projecting (fig. 13); it is (36 mm.) broad and (16 mm.) high; on the front side regularly furrowed by fine reticulated lines, which produce the appearance of a serpent's skin (Pl. IV. fig. 5); the upper edge of the veil is smooth or showing only traces of dentition;² there is no trace of the grooved fold on each side at the base of the veil found in the *Tr. Hombergi*; the end of the muzzle beneath the middle of the veil is contracted. The sides of the body somewhat high and convex, a little lower in the anterior part; decreasing in height from the region of the anus backward. The upper genital opening was entirely filled by the flagelliform penis (Pl. III. f. 13d) which was about 20.0 mm. long, with a diameter at the base of 3.0, and at the tip of 0.5 mm. The larger mucous gland (fig. 13) was below this opening. Behind the middle of the body is the crateriform anal papilla projecting about 3 mm., in the orifice of which are strongly projecting folds (Pl. III. fig. 15a) before which is the renal opening also provided with internal folds (fig. 15b). The foot is as long as the back, rounded in front, with a marginal groove which extends beyond the region of the genital orifices; the foot projects laterally some 3-4.0 mm. from the body. The tail is short, hardly 3.0 mm. long.

The peritoneum is colorless, the viscera not in the best preservation in the specimen examined.

The central nervous system closely resembles that of the *Tri-*

the buccal ganglia (Pl. IV. fig. 6) are rather large, of oval outline; the gastro-oesophageal rather short-stalked, ovoid, with three large cells (fig. 6a).

The eyes are as usual.¹ The otocysts about 0.2 mm. in diameter contain about sixty round or oval *otoconia*, reaching from 0.025 mm. rarely to 0.04 mm. in diameter, many of them marked with a few fine concentric lines.² The skin is almost free from spiculæ, they are almost entirely absent from the interstitial connective tissue.

The oral tube is rather short, about 6.0 mm. long, wide, with the usual longitudinal folds. The *bulbus pharyngeus* is strong, about 16.0 mm. long by 14.0 mm. broad and high. The form is in general shorter and stouter than in the typical *Tritonia*. The "muscle-plate" on the front side as in *Tr. Hombergi*.³

The jaws (Pl. IV. fig. 7) shorter, broader, and higher than in the *Tr. Hombergi*; the length of the united jaws was 12, the

¹ The eyes in *Tr. Hombergi* show black pigment and a yellow lens, they are about 0.23 mm. in diameter. The *nervus opticus* is about four times as long as the cerebro-visceral ganglion, and issues from a small ganglion situated near the pedal ganglion, giving out a nerve before reaching the eye, and continued in a third nerve beyond the eye. Cf. Ihering, l. c. p. 154.

² Alder and Hancock did not discover the otocysts in *Tr. Hombergi*, nor did I, but they were seen by Ihering.

³ The *bulbus pharyngeus* of the *Tritoniæ* is, as also the tongue, very like that of the *Pleurophyllidiæ*, but somewhat more flattened (cf. my *Bidrag til en Monografi af Pleurophyllidierne*, Naturh. Tidsskr. 3 R. iv. 1868, pp. 224-336). The lip disk at the bottom of the oral tube is as in those; also the thick muscular plate at the front of the jaws (cf. l. c. p. 229), and with the usual transverse groove. In two individuals of the *Tr. Hombergi* of the length of 7.5 and 5.5 cm., the *bulb. phar.* had the length of 20 to 23 mm., a breadth of 12 to 15 mm., and a height of 11.5 to 15.0 mm., or the length of the bulbus amounted to about one-third that of the body; on the surface of the bulbus were marked partitions nearly as in the *Pleurophyllidiæ*; the sheath of the radula on the hinder and upper end of the bulbus was distinct, but not prominent. The united jaws 23 to 24 mm. long, with a breadth of 12 to 16, and a height of 6 to 7 mm.; the breadth of the jaw alone behind the articulation about 2.5, on the broadest part 6.75 to 7.0 mm.; the free part of the *proc. masticator.* 1.5 to 2.0 mm. long; the articulation rather prominent in front; nearly the posterior half of the cutting edge is serrated, every denticle composed of several, more or less coalescent, conical points, elevated about 0.16 mm.; a deep furrow for muscular insertion nearly parallel with the cutting edge.

breadth 13 mm., and the height 5 mm.; the jaw alone had behind the articulation (fig. 7a) a breadth of 5.5 to 7.0 mm. in the hinder part;¹ the length of the (free part of the) *proc. masticatorius* (fig. 7b) 1.5 mm.; the articulation rather prominent in front; the cutting edge in the posterior part slightly undulated, but plain, under the microscope covered with many irregular series of irregular prismatic bodies (fig. 16) about 0.02 mm. high. The tongue is large, broad, and high; the radula narrower than in *Tr. Hombergi*, brownish-yellow, with nineteen series of teeth.² On the under side of the tongue, moreover, the marks of eight series of teeth remain, the teeth themselves having been dropped. There were under the *lectum radulae* and in the sheath twenty-five fully developed series, and six which were yet only partly colored. The number of series in all fifty. The number of teeth was, in one of the foremost series of the radula, about two hundred and twenty-five (on each side), and the number seemed not to increase notably farther backwards. The *median* tooth is like a compressed pyramid, somewhat narrower in the hinder part (Pl. IV. fig. 8aa; Pl. V. figs. 1aa, 2a), with the upper part bent backwards (fig. 8); the posterior margin more or less rounded, the anterior margin (fig. 1aa) with a slight cleft, the continuation of which (fig. 2a) forms a groove on the anterior side of the pyramid. The first lateral tooth shaped nearly as the medial is, but (fig. 8bbcc, 1bb, 2) narrower and longer, the (fig. 8) upper part less prominent, less crooked, and commonly more rounded at the top (fig. 8). The *second* lateral tooth either nearly like the first (fig. 8d), or with a distinct beginning of the form (fig. 1e, 2), that reigns through the later series of external teeth (fig. 1bb, 2); these lateral

not thickened, flexible process (fig. 9). The one to two *outermost* teeth small and in form very variable (fig. 10aa, 11aa). The teeth (in their thickened parts) of yellowish color, somewhat darker and less clear than in the typical species. The length of the rachidian teeth in the hinder part of the tongue 0.2 mm.; the greatest height of the lateral teeth (in about the same region) 0.4 mm. Double plates (fig. 12) were present.

The *glandulae salivales* were clay-yellowish, about 25.0 mm. long, rather flattened; about 10.0 mm. broad on the under side, separated by the oesophagus; on the upper side confluent in a large convex plate about 25.0 mm. broad. The efferent ducts were short.

The oesophagus was about 38.0 mm. long, with a diameter of 11.0 mm., and rose from the foremost part of the *bulbus pharyngeus*; in the posterior half were rather strong longitudinal folds passing without distinct limits into the stomach. The latter formed a moderately sized sac at the anterior part of the liver; the under side was free, the upper decked by a flat lobe of the liver. The stomach was somewhat compressed; in antero-posterior direction about 9.0 mm. high; the *cardia* were wide with two salivary orifices in the posterior part; above, a rather narrow pylorus with very strong folds; the walls of the stomach are rather smooth. The intestine issues from the uppermost part of stomach, appearing on the surface of the liver at the left side of the heart, following the left margin of the liver forwards, lodged in a groove on the surface, but backward at the front and end of the liver, following the right side of that organ, somewhat descending, then ascending again and terminating at the anus. The antero-ly proceeding part of the intestine was about 25.0 mm. long, the rest was about 50.0 mm. long, of which 15.0 mm. belonged to the part which ascends to the anus. The diameter of the terminal portions of the intestine was about 3.0 mm., of the middle portion nearly 7.0 mm. Through nearly the whole length of the intestine, and nearly reaching to the knee of the last ascending part, was a strong and thick fold of about 3 mm. in height; the last part of the same for a length of full 4 mm., free and projecting wing-like. Fine longitudinal folds, often shining through the walls of the intestine, were moreover seen through the whole length of it, in the first part especially strong on the under side; in the last part finer, partly ending in the folds of

the anal opening (Pl. III. fig. 65a). The contents of the intestine, stomach, and oesophagus were indistinct animal matter.

The liver of a clay-yellowish color, large; the length about 4.7 mm., with a breadth of 3.0, and a height of about 2.6 mm.; the hinder end rounded; the foremost half of the lower lobe wanting, its place occupied by the stomach; the front, therefore, very oblique, sloping backwards and somewhat towards the right side (with an impression for the large anterior genital mass). On the surface of the liver rather superficial furrows in different directions, especially transverse; through the middle part of the upper side of the liver, beginning at the right side, a somewhat deeper longitudinal furrow diverges towards the left side, containing the renal chamber; at the junction of the first and the second third of the upper side a very deep transverse groove for the pyloric part of the intestine (which turns to the left); but the part of the liver before the groove is a continuation of the whole liver, and not only of the left part of it (as in the *Tr. Hombergi*). The structure of the liver is as in the typical form.

The atrium and ventricle of the heart are as usual, the ventricle 2.0 mm. long, and the renal syrx about 3.0 mm. long, of the usual structure; the renal chamber, as far as it could be determined, as in the *Tr. Hombergi*.¹

The *gland. hermaphrodisiaca* not distinguishable in color from the liver, covering the surface of that organ nearly as in the *Tr. Hombergi*, and of similar structure. The follicles contained zoöperms and large oögene cells.

The anterior genital mass very large, 3.0 mm. long, 1.8 mm.

the whole length of the everted penis, with several irregular dilations and constrictions through the posterior part, and ending on the blunted point of that organ with a small round orifice. The spermatoduct is attached to the walls of the penis by abundant connective tissue; its wall is very thick; the inside in the posterior part with some strong longitudinal folds, clothed with a fine epithelium, which towards the end of the penis is about 0.07 mm. in thickness. The (Pl. III. fig. 13d) penis, as above stated, flagelliform, about 20.0 mm. long, under the loop furnished with a whitish covering, partly confluent, partly scattered; in the skin through the whole length of the organ an infinity of bottle-shaped, glistening glands about 0.035 to 0.04 mm. in length. The *spermatheca* pyriform, about 9 mm. long, passing without precise limit into a short ductus, that is a little dilated in the inferior part (vagina). The large mucous gland convex in front; on the back rather flat toward the anterior part, in the posterior excavated (for the reception of the ampulla of the hermaphroditic duct); the duct short; the cavity of the organ narrow, empty.¹

DORIDIDÆ.

This large group is easily distinguished through the (retractile or not retractile) branchial rosette on the middle of the back. This character is only found in a single other group of gastropoda, the *Doriopsidæ*, which, in their exterior characters, closely simulate the *Dorididæ*, and had been confounded with them, at least so far that they were regarded as both belonging to a single large group, until my examination of them² showed their affinity to the *Phyllidiidæ*,³ with which they were combined by me in a larger group, the *Porostomata*, particularly characterized through their poriform "outer mouth," and the conversion of the *bulbus pharyngeus* into a quite unarmed sucking apparatus. On the contrary the *Dorididæ* all show a very well-developed *bulbus*, with a more or less strong tongue; and often also a particular armature of the lip-disk on the anterior end of the *bulbus*, and

¹ Pallas (l. c. p. 238, fig. 22^ab) seems to have seen different parts of the anterior genital mass.

² R. Bergh, neue Nacktschnecken der Sudsee. Journ. der Mus. Godeffroy. Heft viii. 1873, pp. 82-94, Taf. x. xi.

³ R. Bergh, Beitr. til Kundsk. om Phyllidierne (Schjölde Natur. Tidskr., 3 R. v. 1869, pp. 357-543, tab. xiv.-xxiv.

lip-plates of rather different kind and nature. With the *Doriopsideæ* (*Porostomata*) the *Dorididæ* agree in the presence of *two spermatothecæ*, and of a vascular gland connected with the central nervous system.

There have been detected but a small number of the generic forms and species belonging to this large family during Dall's expeditions.

ARCHIDORIS, Bergh.

Doris auct.

Archidoris, Bergh, Malac. Unters. (Semper, Philipp. II. Heft xiv. p. 616, 1878).

Corpus sat molle subdepressum. Tentacula humilia, plicæ-formia intus altiora. Dorsum tuberculosum et granulosum. Branchia (retractilis) e foliis tripinnatis formata. Podarium sat latum, margine anteriore superficialiter sulcatum.

Armatura labialis nulla. Radula rhachide nuda, pleuris multidentates; dentes hamati. Ventriculus liber. Penis inermis.

When Linné, in the tenth edition of his *Systema Naturæ* (1758), founded the genus *Doris*, he referred but one species to it (cf. my Mal. Unters. [in Semper, Reise Philipp. II. ii.], Heft x. 1876, p. 388), his *D. verrucosa*. This, which was founded only on the figures of Seba and Rumphius, is probably indeterminable, and the *Doris* of the tenth edition of the Syst. Nat. should, therefore, not have been retained.

In the twelfth edition (1767) the genus embraces, beside *D. verrucosa*, which still figures as first species, three other forms, the



gill composed of (a not large number of) tripinnate leaves. The lip-disk clothed with a simple thick cuticula. The radula with naked rhachis, the pleuræ with numerous hook-shaped uncini. The ventricle is large, free. The penis unarmed.

The group, so far as yet known, contains but few species.

1. *A. tuberculata* (Cuv.).
2. *A. fumosa* (A. et H.).
3. *A. montereyensis* (Cooper).

***Archidoris Montereyensis* (Cooper), Plate XVI. figs. 6, 7.**

Doris Montereyensis, Cooper, on new or rare Moll. inh. the coast of Cal.; Proc. Cal. Acad. Sci., ii. p. 204, 1863; iii. 1868, p. 58.¹

Archidoris Montereyensis Bergh, l. c. p. 624, Taf. LXVIII. fig. 24.

Color luteus vel ochraceus, supra maculis nigris sparsis et seriatis notatus.

Hab. Mare Pacificum. (Monterey, Cal. to Sitka, Alaska.)

Four specimens of this form were collected by Bischoff at low water in Sitka Harbor. Two were small and two much larger, but otherwise similar in every respect. No notes have been received in regard to the living animal. The specimens were sent me in a dried condition. They were of a yellowish or ochraceous yellow color with a larger or smaller number of roundish black spots on the back, here and there confluent in irregular large patches on the middle of the back, which were nevertheless indistinctly arranged in two series. The specimens measured 18.0–40.0 mm. in length, 11–24.0 mm. in breadth, and 5–13.0 mm. high. The width of the rhinophoral orifices in the largest specimen 4.9, and of the branchial aperture 10.0 mm. The back was covered, quite as in the typical species, with large and small rounded tubercles, reaching 1.5 mm. in diameter in the largest individual. The foot was large, exactly as in the typical species; the tentacles, as far as could be determined, of the usual kind.

In two of the individuals the gill was expanded, and the number of the branchial leaves 80.

Through the kindness of Mr. Dall I have had the opportunity

¹ "Pale yellowish, with scattered black spots (or entirely brown?); mantle rough, tuberculate, or nearly smooth; dorsal tentacles knob-shaped; branchial rays bipinnate, short, in eight divisions, forming a crown-shaped expansion on the posterior third of the dorsum. Foot expanded into broad, thin margin as wide as the mantle. Length 3", breadth 1" !, form elongated oval." Cooper, l. c.

of examining a colored drawing of the animal made by Cooper. The color of the back was here ochre-yellow, with scattered small and some larger black spots; on the middle of the back especially several larger elongate irregular patches; the rhinophoria of somewhat more reddish color. In the gill eight leaves.

Through cautious emollition of one of the larger and one of the smaller individuals the nature of the *lip-disk* and of the armature of the tongue could be determined. The former was quite as in the typical species. The *tongue* showed thirteen to fifteen rows of plates; the number of rows further backward could not be determined with certainty, there seemed to be about fourteen to fifteen developed rows, and the total number of plates thus seemed scarcely to exceed thirty-three to thirty-six. The series seemed to contain about sixty to seventy plates. These plates (figs. 6, 7) were very like those of the typical species, perhaps the hook was a little slenderer; the height of the outermost plates (fig. 7) was commonly about 0.1–0.15, and the height increased through the series of plates to about 0.28 mm.

Perhaps this form might prove to be merely a variety of the *D. tuberculata*.

CHROMODORIS, Alder and Hancock.

Chromodoris, A. and H. Mon. Brit. Nudibr. Moll., vii. p. xviii. 1855. R.

Bergh, Neue Nacktschn. der Sudsee II. in Journ. der Mus. Godeffroy, Heft viii. pp. 72–82, 1875, and iv. 1. c. Heft xiv. pp. 1–21, 1878.

Goniobranchus, Pease, Am. Journ. Conch. ii. 1866, p. 204.

Doriprismatica, A. d'Orbigny (pp.), Moll. des Isles Canaries, 1834, p. 40, note.

In the latest of my cited papers was moreover given a supplement to the former list of described or denominated *Dorides*, that could be referred with more or less probability to this group. The number of species amounted to about ninety.

In external form the *Chromodorides* somewhat agree with the *tricolorides*, but have much more gay and handsome colors, mostly forming longitudinal stripes. The tentacles are small, conical; the (retractile) rhinophoria with densely perfoliated club. The margin of the mantle on the anterior and posterior ends developed in a frontal and a caudal veil, which sometimes shows peculiar knots.* The (retractile) gill is formed of simply pinnate plumes, sometimes divided at the top. The foot rather narrow. The *lip-disk*, with an annular hard lamina, composed of densely set small hooks, mostly bifurcated at the top. In the radula no median plates, but often on the rhachis peculiar thickenings (pseudo-plates). The lateral plates, of ordinary form, nearly always serrulated or denticulated on the margin of the hook. The penis unarmed.

In the southern part of the Pacific the *Chromodorides* are represented by a whole series of species; from the northern part (China) only a few representatives are known; among the specimens sent by Dall only two species were detected, the hitherto known most northern representatives of this group, of which no form has yet been found in the northern part of the Atlantic.

Chromodoris Dalli, Bergh, n. sp., Plate XIII. f. 1-7. Plate XIV. f. 1-4.

Hab. Oc. Pacific, sept. (Puget Sound, Washington Territory.)

An individual of this species was obtained, during the progress of the U. S. Boundary Commission, by Dr. Kennerly, the lamented naturalist of the U. S. party, in Puget Sound. No notes have come to hand in regard to the living animal.

The animal preserved in spirits was 11.5 mm. long, 5.5 broad, and 4.2 mm. high. The height of the rhinophoria was 1.25 mm., of the tentacula 0.75 mm., of the branchial leaves 2.0 mm.; the breadth of the mantle margin 1.2 mm., of the foot 2.5 mm., and the length of the tail was 2.5 mm. The ground-color of the back and sides isabelline-gray, everywhere covered with small, and still smaller, coal-black, rounded points about 0.25 mm. in d

* Such knots have been found (by me) in the *Chr. ruficamaria*, *elegans*, *glauca*, *gonatophora*, and *Ocellularia*.


meter, which were also visible on the under side of the mantle edge and on the upper side of the foot. The sides were also abundantly furnished with bright yellow points, appearing in smaller number also on the back where they are, for the most part, represented by yellow ocelli with darker yellow pupils. The mantle-edge had a yellow margin on the upper side; there was also a fine yellow line along the upper side of the edge of the foot. The stalk of the rhinophoria was gray, the club (grayish) reddish. The branchiae and tentacula grayish-white with a yellow colored rhachis on the outer and posterior edge.

The branchial leaves with a few scattered black points, the margin of the orifice for the rhinophoria and of the gill cavity embellished with a yellow line.

The form as usual; the mantle edge rather prominent, the frontal and caudal veil not particularly developed (without traces of larger nodules on the under side). The club of the *rhinophoria* strong, with about thirty broad leaves; the tentacles conical (as it seemed), retractile in a little cavity. The *gill* consisting of fifteen (Pl. XIII. fig. 1) simple plumes; increasing four times in height from the posterior involute end gradually forward. The angles of the anterior margins of the foot not very prominent.

The intestines not shining through the walls of the body; the peritoneum colorless.

The central nervous system yellow. The *cerebro-visceral ganglia* reniform, the two divisions of nearly equal size; the rounded *pedal ganglia* a little larger than each of them; the great commissure not short. The proximal *lateral ganglia* of about the same size



The *bulbus pharyngeus* 2.5 mm. long by 2.0 mm. broad and high. The radula reddish-gray, freely projecting about 2.5 mm. The armature of the lip-disk broad, rather thick, fine horny-yellow, consisting (Pl. XIII. fig. 2) of rather long (0.06 mm.) hooks, somewhat curved at their upper ends and slightly bifurcated at the point (fig. 3).

The tongue as usual, with about forty rows of teeth, behind which were sixty-six rows of developed, and six rows of immature teeth, the total number being one hundred and twelve. The teeth of yellowish color, except the rhachidian and external uncini, which were nearly colorless. The height of the second lateral (Pl. XIV. fig. 2) about 0.035 mm., of the most elevated teeth about 0.05 mm., of the outermost uncini 0.025 to 0.03 mm. On the narrow rhachis was a median pseudo-plate (rhachidian boss) about 0.035 mm. long, pointed anteriorly (Pl. XIII. fig. 4; Pl. XIV. fig. 1) broader and rounded behind (Pl. XIII. fig. 5) consisting of a high anterior portion which falls abruptly toward the plain part, slopes gradually towards the fore-end, and is divided by a longitudinal groove into two halves (figs. 4, 5). On each side of the median plate twenty-seven to twenty-nine laterals. The lateral teeth of usual form, somewhat low; the (Pl. XIV. fig. 2) first with four to five denticulations on each side of the low hook; the rest (figs. 6, 7, 8) with such only on the outer side, mostly with six to seven, more rarely (especially on the innermost plates) with four to five, or at the utmost with eight to nine denticles; the six outermost of the usual aberrant form, without denticulations (Pl. XIV. fig. 3).

The *salivary glands* long, ribbon shaped, whitish. The *oesophagus* as usual; the intestine filled with large pieces of a *Ceratopogon*, mixed with some fragments of the lip-plates and some teeth from the radula. The *liver* about 6.0 mm. long by 3.0 mm. broad and high, truncate at the fore-end, rounded behind; the substance yellow.

The *renal layer* rather thick. The *sanguineous gland* whitish.

In the cavities of the *hermaphroditic gland* were zoösperms. The *anterior genital mass* about 3.5 mm. long by a height of 3.0 and a breadth of 2.0 mm. The *ampulla* of the hermaphroditic duct rather (about 2.5 mm.) long, yellow. The *spermatoduct* very long; the first, darker, part forming a large flattened coil, the second passing into the short *penis*. The an

(Pl. XIV fig. 4a) of a diameter of about 1 mm ; the longer *spermato-cysta* forming a long *cul-de-sac* (fig. 4b). The *mucous gland* whitish, in the neighborhood of the anterior end was a *yolk-yellow* part.

2. *Chromoderis Californiensis*, Bergh, n. sp. Pl XII. fig 5 to 15.

Color caeruleus, dorso et lateribus punctus majoribus aureis ornatus.

Hab. Oc. Pacific. septentr. (coast of California, Santa Barbara Islands).

Of this very handsome species Dall obtained an individual on *algæ* at low water in the harbor of Catalina Island, California, January, 1874. (Specimens have also been seen from Monterey and San Diego.—W. H. D.)

The color of the living animal, according to Dall, was "ma-zarin-blue with golden spots" (changing to greenish-blue in the alcohol, which it continues to color for a long time, and after several changes for fresh spirit.—W. H. D.).

The rather contracted animal in spirits was 12.0 mm. long, and 6.0 mm. broad and high. The height of the retracted rhinophoria was 1.3 mm., of the retracted branchial plumes 1.5 mm., the length of the tail about 2.5 mm., and the breadth of the foot 2.0 mm.

The color was uniformly greenish-blue (which it had also given out to the alcohol). On the back were several yellowish-white, round spots, a millimetre in diameter. On the anterior part they were chiefly in the median line, on the rest in two longitudinal series, outside of which on the back were scattered some similar spots, and on each side of the head was a line of four or five more

The central nervous system as usual, but less depressed, and of greenish color; the cerebro-visceral ganglia reniform, somewhat broader in front; the distinction between the *cerebral* and the *visceral* parts very pronounced, the latter a little smaller than the former; the pedal ganglia rounded, a little larger than the visceral. The buccal ganglia larger than the (proximal) olfactory, roundish, connected by a rather short commissure; the gastro-oesophageal roundish, having about one-tenth of the size of the former, rather short-stalked, developed on one side of the nerve, with one very large and a few smaller cells. The proximal olfactory ganglia rather depressed—bulbiform; the distal ones much smaller, of oval form.

The lens of the eye was greenish-blue, the pigment brownish-black; the retina bluish. The otcysts were as usual. There were no spicules in the skin, the leaves of the rhinophoria or the interstitial tissue, which was always of a greenish-blue color. The nodules of the caudal veil resembled those of other species possessing them.

The oral tube was about 2.5 mm. long, and 1.6 mm. in diameter at the posterior end; of greenish-blue color throughout. The *pharynx* of the same or a darker shade, about 3.0 mm. long, by a breadth of 2.5 mm., and a height of nearly 2.0 mm.

The large sheath of the radula prominent posteriorly is also about 1.0 mm. in diameter. The lip-plates are of a grayish olive-green color, separated at their upper (fig. 6) and more widely at their lower ends. The plates are scarcely narrower above, the nearly uniform breadth being 1.5 mm. The elements of the plates reach the length of 0.045 mm., with thick, recurved, hooked points (figs. 7-10), these last were seldom cleft (fig. 10). The elements adjacent to the spaces between the plates were much smaller and of irregular form (fig. 6). The tongue was of the usual form, the radula shining like silver and grayish-green in color. In the radula were thirty-five rows of plates, behind which were fifty-one well-formed and six immature rows; the total amounting to eighty-two rows. In the posterior rows of the tongue were ninety-eight teeth on each side of the narrow and naked rhachis. The teeth had a very pronounced greenish hue; rising to the height of about 0.1 mm., that of the outermost was about 0.04 to 0.06 mm. The form as usual; the hook bifurcated at the point, the outer and posterior branch shorter, denticulated and the den-

ticulations continued downwards along the exterior margin of the hook (fig. 13). The innermost teeth (fig. 11) lower and with fewer denticles; the largest number of teeth generally with about six to eight denticles; the outermost plates (fig. 14) of the usual modified form, sometimes rather irregular (fig. 13).

The (about 7 mm.) long, ribbon-formed salivary glands through their white color contrasted with the green of the adjacent viscera in their foremost part broader, having a breadth of about 0.6 mm. in the rest of their length thin.

The liver grayish-green, about 5.5 mm. long, by a breadth of 4 and a height of 3 mm.; the substance more yellow. The heart and especially the renal region, of greenish color. The sanguineous glands greenish, much flattened; the anterior linguiform about 1.75 mm. long, with a breadth of about 0.6 mm.; the posterior of about the same length, a little broader. The anterior genital mass small, about 2.5 mm. long, by a breadth and a height of 1 mm. of blue-green color, as were the different component organs of the mass. The spermatheca as usual, spherical; the spermatocysts shorter than in the former species. The penis as in other species.

CADLINA, Bergh.

Corpus sat depressum; dorsum granulatum, vix asperum; branchia retractilis, e foliis tripinnatis paucis formata; caput parvum tentaculis brevibus, applanatis, triangularibus quasi; podarium sat latum, sulco marginali anteriore profundo.

Armatura labialis lamelliformis, fere annuliformis, e hamulis minutissimis formata.



formed of densely set (bifid) hooks. The rhachis of the tongue with a depressed plate with a low denticulated hook; the pleuræ with a series of hook-shaped teeth, the inner denticulated on both edges; the outer only on the exterior margin. The glans penis armed with rows of small hooks. A spoon-shaped process at the upper wall of the vestibulum.

Alder and Hancock have given some notes on the nervous and genital systems and on the structure of the radula of the typical species, which has also been the subject of some observations by Meyer and Möbius.

Up to the present time only three species of the genus are known, two belonging to the northern part of the Atlantic, the third to that of the Pacific; nothing is known of their spawn or their biology.

1. *Cadlina repanda* (A. & H.). Oc. Atlant. sept.

2. *Cadlina glabra* (Friele & Hansen).

Doris glabra, Fr. & Hans., l. c. p. 3. Oc. Atlant. sept.

3. *Cadlina Pacifica*, Bergh, n. sp. Oc. Pacific. sept.

1 *Cadlina repanda* (A. & H.). Pl. V. fig. 15; Pl. VI. figs. 21, 22; Pl. VII. figs. 9-18. Pl. VIII. figs. 3-6.

Doris repanda, A. & H. Monogr., Part III., 1846, Fam. I. pl. 6; Part V., 1851, Fam. I. pl. 1, figs. 10, 11; pl. 2, fig. 14, Part VI., 1855, app. p. II. pl. 46, suppl. fig. 7.

Hancock and Embleton, Anat. of Doris, Phil. Trans., 1852, II. p. 212, 215, 219, 233, Pl. XI. fig. 3; Pl. XII. figs. 11-13; Pl. XIV. fig. 5; Pl. XV. fig. 5; Pl. XVI. fig. 10; Pl. XVII. fig. 9.

Meyer and Möbius, Fauna der Kieler Bucht, II. 1872, p. 68, Taf. fig. 17.

Doris lævis, Fleming, Brit. Anim., p. 282, 1828.

Doris obvelata, Lovén, Ind. Moll. Scand., p. 4, 1846. Sars, Reise til Lofoten og Finnmarken, p. 76, 1851.

Color lacteus vel luteus, limbo palliali supra maculis luteis vel lacteis distinctus.

Branchiæ e foliolis quinque compositæ.

Hab. M. Atlant. sept.

It is useless to discuss the question, if the *D. lævis* Linné represents this species; if this in reality was the case, the name of Linnæus ought to be re-established, as it has been done by Mörch' (*Acanthochila lævis*, M.). It is scarcely worth while

* Cf. Mörch, Faunula Moll. Islandiæ, Naturh. Foren. vidensk. Meddel. 1854, p. 203.

examination it is in many cases not possible even the genus, to which in reality the species belongs described and figured by Alder and Hancock as *D.* the contrary determinable, and this name ought to be although perhaps identical with the elder denomination and of Müller.

Of this species I have had five specimens for examination; two kindly sent me by Mr. Friele, of Bergen, in that vicinity; two from Samso, Kattegat, and from of Zeeland (Denmark), and one from the neighborhood for which I am indebted to the friendship of Prof. individuals agreed in their internal and external structure.

The color of alcoholic specimens was uniformly lowish-white. The Norwegian specimens were 11-14 6.5-8.0 mm. broad, and 3.5-6.0 mm. high. The breadth of foot was 2.6-4.5 mm., of the mantle-edge 1.5-2.5 mm. of the rhinophoria 1.2-2.0 mm., of the gill 1.5-2.5 mm. corresponding measurements of the Danish specimens were 14.0-15.0, 8.-9.0, 4.-6.0, 3.5-3.75, and about 2.0 and 3 length of the individual from Kiel was about 8.0 mm.

The form was rather depressed, the outer part of edge not thick. The back was covered all over with very small papillae, obtuse or more pointed, low and

The rhinophorial orifices were not prominent, but crenulated on the margin. The club showed fifteen

leaflets.' The opening of the branchial cavity rather small (diameter 1.5-2 mm.) round, not prominent, with a reflexed and scarcely crenulated margin. The gill consisted of five tripinnate leaflets, the anterior median hardly smaller than the others. The two anterior laterals were often cleft so as to simulate two plumes. The anal tube was short, truncate, situated between the two posterior branchial plumes, the renal orifice at the right side.

The head was small, consisting of the mouth and two small flattened tentacles, with a furrow along their outer margin. The flattened genital papilla furnished with a rather contracted orifice; in its upper part always a more or less (1.0 mm.) projecting triangular or spoon-shaped lobe (figs. 21, 22). The foot straight or a little rounded in the forepart, strongly grooved in the margin, the upper lip slightly cleft in the median line.¹ The peritoneum colorless. The five individuals were dissected.

The central nervous system showed the cerebral ganglia of rounded triangular form, sometimes somewhat elongate, larger than the visceral ones, which are more rounded. In connection with the basal part of the under side of the right cerebral ganglion was a small rounded ganglion (of about 0.07 mm. diameter) prominent between the hinder part of the cerebral ganglia, and giving off a long nerve backwards. In connection with the anterior part of the upper side of the cerebral ganglion was an optic ganglion, a little smaller than the former; the *n. opticus* rather short. In connection with the posterior part of the under side of the visceral ganglion through a rather short nerve is an oblong *ganglion genitale*,² giving off a long nerve to the anterior genital mass (penis³); the ganglion containing cells of rather unequal size. The pedal ganglia are situated perpendicularly or oblique to the former, and a little compressed. The commissure rather broad and short, as long as the largest diameter of the pedal ganglion, the proximal olfactory ganglion bulbiform, very short stalked, a little smaller than the buccal ones. No true distal was observed. The visceral

¹ According to A. and H. the number of leaflets is twelve to thirteen, and to Meyer and Moebius fourteen.

² Both A. and H. and Meyer and Moebius mention five plumes.

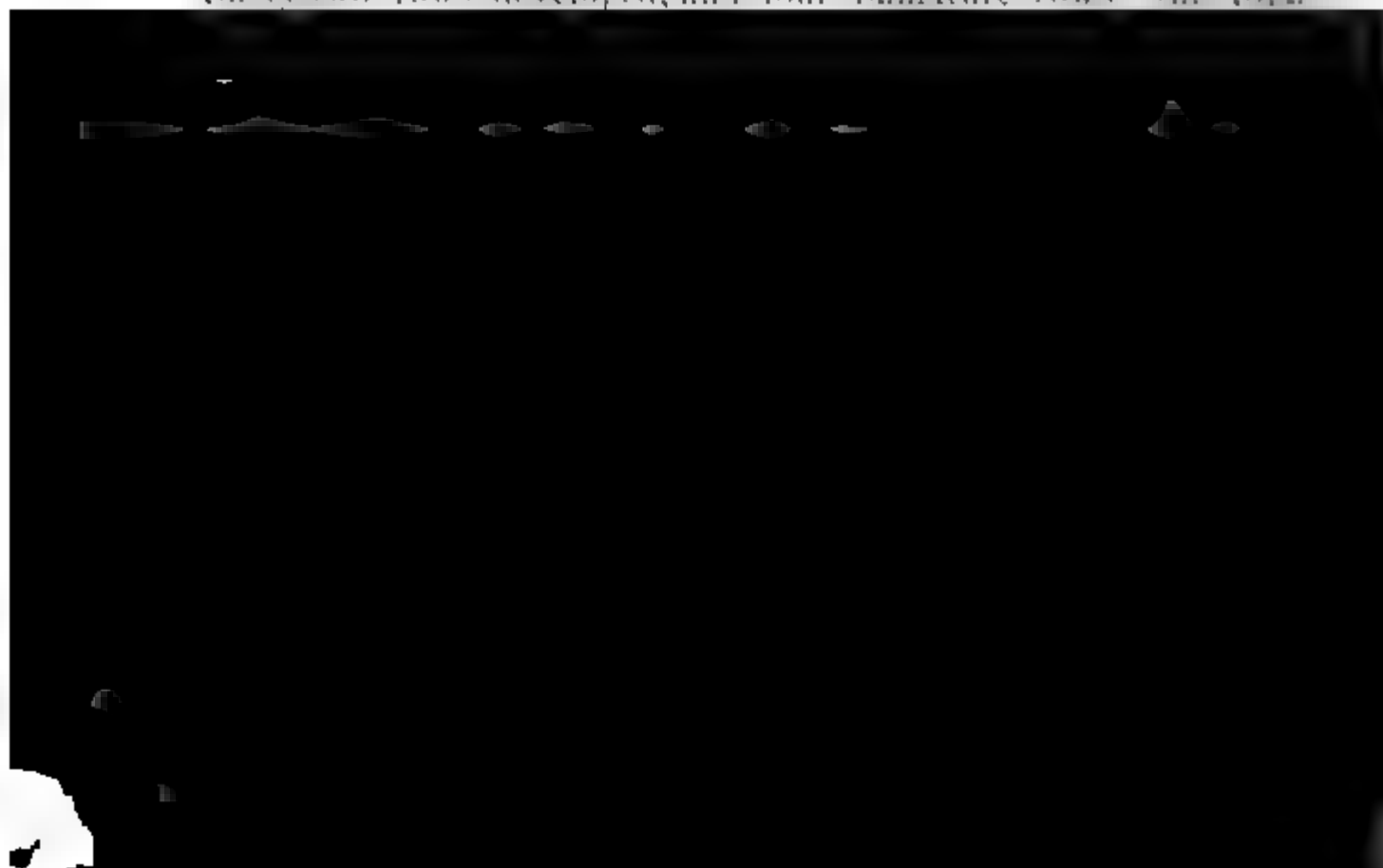
³ The markings on the under side of the mantle brim (cf. Alder and Hancock, p. 12, fig. 2) were not visible.

⁴ The ganglion had already been seen by Hancock and Embleton (loc. cit. XVII fig. 9).

ganglia were of oval form, connected by a very short commissure; the gastro-oesophageal oblong, about one-eighth the size of the last, short stalked, developed on the side of the nerve; with a single large and several small cells.

The eye showed a yellow lens and deep black pigment. The otocysts visible as chalk-white spots under the loop in the usual position, with about one hundred otoconia of the ordinary kind. There were sparingly scattered calcified spiculæ, 0.25-0.30 mm. long, in the broad and rather thick leaves of the rhinophoria, set perpendicularly or obliquely on the free margin of the leaves. The skin was profusely furnished with large and small rod-shaped spiculæ, mostly much calcified; in the axes of the granules of the back were bundles of perpendicular spiculæ as usual. In the interstitial connective tissue a very few large spicules.

The oral tube was wide (1.0-2.5 mm. long). The *bulbus pharyngeus* of the usual form, about 1.3-2.25 mm. long, 1.2-2.0 mm. broad, and 1.0-1.75 high. The radula also projected 0.3-0.75 mm. from the posterior part of the under side of the *bulbus*. The true mouth of triangular form, the point upwards. The lip-plate was deep horn-yellow, narrow at the upper end and broader downward at the lowest square part about 0.66 mm. broad; it is composed of densely set hooks, cleft at the point and rising to the height of about 0.033 mm. (figs. 9, 10). The tongue broad and flat; in the five individuals examined, furnished with twenty-six, twenty-seven, thirty-six, thirty, and fifteen rows of teeth; further backwards thirty-three, thirty-four, twenty-eight, thirty-six, and thirty-two rows developed, and four immature rows. The total

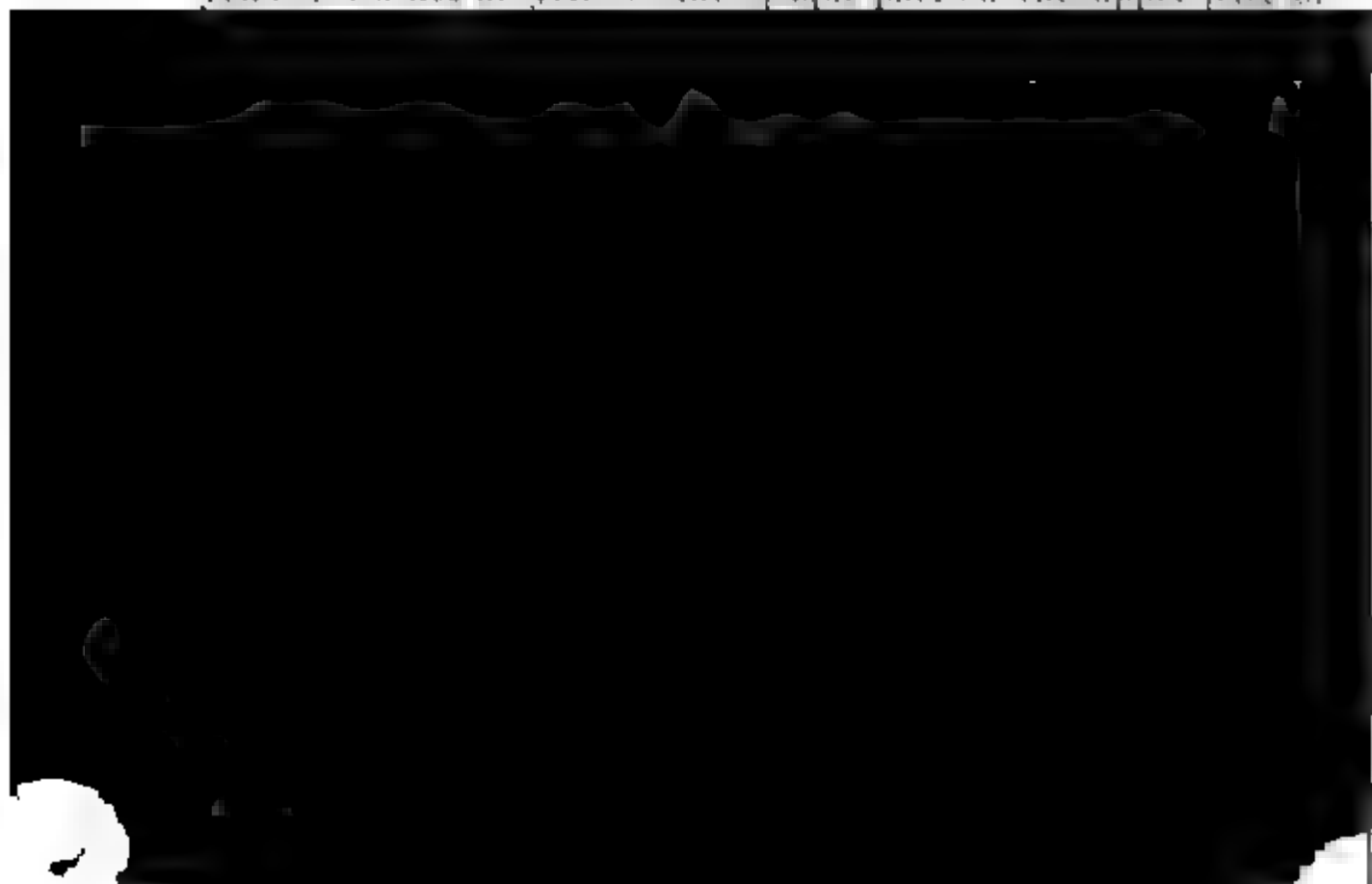


incomplete. The first plate with seven to nine denticles at the outer side of the hook, and with three to four on the inner side (figs. 1166, 1266). The second and third (fig. 14) with broad basal plate, as (figs. 14, 3) also all the succeeding plates without denticulation of the inner margin, on the outer edge (Pl. V., fig. 15) a certain number of denticles, increasing to twenty or twenty-five. In the outermost part of the rows the number of denticles decreased (fig. 15); the outermost plates were of very variable form (figs. 15a, 4a). The height of the outermost plate sometimes only 0.007, generally 0.04-0.05 mm., the height of the next plate about 0.05, of the next 0.075 mm.; the height rising to about 0.1 mm.; the height of the innermost lateral plate 0.04, of the fifth 0.06 mm. The color of the plates was pale yellow, the outermost colorless.

The salivary glands strong, whitish or yellowish, flattened, with a breadth of 1.5 mm., forming two to three short coils at the sides of the oesophagus, the duct very short. The oesophagus, as usual, also the stomach. The intestine emerging from the liver (fig. 17a) behind the middle of its upper side; the first part proceeding as far as the fore end of the liver, in the largest individuals about 18 mm. long, somewhat wider in the pyloric part, the descending part of the intestine nearly 13-17 mm. long, with a nearly constant breadth of 0.75-1 mm. The liver (in the largest individuals) about 1.3-1.5 mm. long, by a breadth of 7-7.0, and a height of 6-7.5 mm., about half of the height anterior part strongly flattened for the reception of the anterior genital mass, the posterior end rounded; the color of the surface yellowish white, the substance when cut yellow. The biliary sac whitish, very distinct (fig. 175) on the surface of the liver, about 2 mm. long, lying at the anterior end of the pyloric part of the intestine, on the right side.

The heart and renal chamber as usual; the last white, very large, reaching to the fore end of the liver. The sanguiferous gland whitish, very flattened, about 1.5-5.0 mm. in largest diameter, covering the central nervous system. The yolk yellow betanaphtholitic gland covering the upper and right side of the liver (fig. 176) occasionally with groups of lobes scattered on the under side but never forming a nearly continuous layer over the liver. The structure was as usual, with large oögene cells and zoöspores in the tubules. The anterior genital mass large, in the largest specimens 8-8.5 mm. long, 3.5-4.0 mm. broad, and

6-7.0 mm. high, ovoid, plano-convex, flattened on the left side. The ampulla of the hermaphroditic duct usually crossed over the left side, whitish, sausage-shaped, 6-7.0 mm. long, by 1.1-2.0 mm. in diameter. The windings of the spermatoduct rested on the anterior margin of the genital mass, the first part thicker but not much longer than the rest, which was thinner and stronger (in the largest individual 7-10.0 mm. long). A stricture unites the two parts, the last passing without definite limits into the nearly cylindrical or elongate-conical (retracted) penis, which was about 1.5-2.5 mm. long, the somewhat elongated glans being straight or curved, 0.5-0.6 mm. in length, by 0.08-0.1 mm. in diameter (fig. 18). It was furnished with irregularly set (fig. 5) rows of pale-yellowish hooks, which rose to a height of about 0.016 mm. They were straight or curved, sometimes irregular or connate (figs. 5, 6), mostly solitary, yet sometimes arranged in small groups (fig. 6); the sperm duct continued (fig. 18a) through the whole length of the glans to the round orifice on the point of the glans; there was no continuation of the armature of the glans backwards over a longer portion of the sperm duct. The spermatheca spherical, about 2-3.0 mm. diameter; its own duct a little longer than the leg, rather wide, then uniting with the thinner and somewhat longer (and wider at the union) duct of the *spermatocysta*, which was also round and of the diameter of 1-1.5 mm.; both organs resting upon the anterior margin of the mucus gland; the vagina about as long as, and a little wider than, the special duct of the spermatheca. The large mucous gland yellowish white or yellow; the opaque part on the upper part of



a slight tinge of olive. The rhinophoria and branchiae of deeper red w. It was about 280 mm. long, 130 mm. broad, and 7.0 mm. high—the foot 7.0 and the free mantle edge 3.0 mm. broad. The rhinophoria 2.5 mm. and the branchial leaflets 3.5 mm. high. It was of rather depressed elongate form, the mantle margin rather broad. The back covered all over with rather small compressed or rounded densely set tubercles, which often coalesced, forming short longitudinal folds. These nearly disappeared at the margin of the mantle. The rhinophorial orifices situated rather forward with several tubercles on their margins, the club of the rhinophoria with twelve to fifteen large and very oblique scales. The opening of the branchial cavity (the branchial leaves retracted) was a longitudinal slit of about 4 mm. in length, and rather narrow; the margin of it with tubercles of the usual kind. The branchial leaves nine in number, four lateral pairs and one anterior unpaired, tripinnate. The anal tube low, with two statoholes (fig. 19); the renal pore in front of and at its right side. The outer mouth a small longitudinal slit, the tentacles very small, with a furrow at the upper part of their outer margin. The under side of the mantle edge even, a small deep groove for the head. The sides of the body rather low, the genital opening round, with at least two openings in its depth. The foot rounded at the fore end with traces of a fine furrow, the posterior end somewhat pointed.

The intestines where visible through the skin. The peritoneum colorless, nearly without spicula.

The central nervous system showed the cerebral and the visceral ganglia very distinct; the cerebral short, reniform, a little broader in the anterior part a little larger than the buccal, bulbiform, short-stalked, the optic ganglia scarcely equal to one tenth of the size of the latter, the optic nerve short. The visceral ganglia short, pyriform; on the under side of the right hand are a short-stalked genital ganglion, intermediate in size between the optic and olfactory ganglia. The pedal ganglia nearly perpendicular on the under side of and a little smaller than the visceral. The commissures rather short, the visceral nearly free from the broad subcerebro-pedal.

The buccal ganglia rounded and connected by an extremely short commissure. The gastro-oesophageal short stalked, ovoid,

about one-eighth the size of the former, developed on one side of its nerve with one very large and several smaller cells.

The eye provided with black pigment, and a yellow lens. The otocysts in their usual place, filled with ordinary otoconia. The broad leaves of the rhinophoria with a rather large quantity of spicula, generally set obliquely or perpendicularly on the free margin. The spicula mostly rod-shaped, long, and much calcified. These also occur abundantly in the skin of the back, often associated in small groups. The tubercles of the back were stiffened in the ordinary way, but there were very few spicules of the larger kind in the interstitial tissue.

The oral tube was about 2.5 mm. long, 1.8 mm. wide at the posterior end, internally as usual; the retractor muscles very strong. The *bulbus pharyngeus* strong, about 3.0 mm. long, 2.5 mm. broad, and 2.1 mm. high. The sheath of the radula projecting about 1 mm., bent upwards. The lip-disk rather broad; the lip-plate broad, broadest below, yellow; the lateral parts with several transverse folds; the elements (fig. 7, 8) scarcely different from those of the typical species, or perhaps a little less crooked, of a height of about 0.05 mm.; the mouth, of triangular form, quite as in the *C. repanda*. The tongue of usual form with about thirty-three rows of plates; further back forty-eight developed, and four immature rows; the total number of them eighty-five; the first ten rows of the tongue more or less incomplete.¹ The number of lateral plates in the hinder row of the tongue thirty-three, the number scarcely increasing in the sheath. The plates of yellowish color; the breadth of the oldest plate (in the hinder part) 0.045 mm., the breadth of these plates increasing to 0.06 mm.; the height of the outermost plates about 0.04, and the height of the lateral plates increasing to about 0.12 mm. The plates of nearly the same form as in the last species. The median plate a little emarginated in the posterior margin; the short recurved hook usually with 3-4 denticles on each side of the point (fig. 9, 10a), sometimes this point was replaced by two single or butid larger denticles (fig. 9). The first lateral plate (fig. 10bb) with 5-6 denticles at the inside, and with 6-7 at the outside of the hook. Through the 4-6 following plates (fig. 10) the size of the plates

¹ The progression was as follows, 6-1-1, 4-1-8, 6-1-7, 10-1-12, 20-1-18, 22-1-19, etc.

and the number of denticles did not much increase, after which both gradually increased as usual (figs. 11-13). Still the number of denticles in the individual examined hardly exceeded 18-22, and was still smaller in the outer portion of the rows (fig. 15). The three or four outer plates were of rather variable form (figs. 14-15) generally without denticles or only traces of them (figs. 14a, 15a).

The salivary glands were yellowish, flattened, ribbon-shaped, 10.0 mm. long, with a greatest breadth in the anterior part of 1.0 (fig. 20), the glands adhering to one another through more than the posterior half; the ducts short (fig. 20a). The oesophagus about 2.0 mm. long, rather thin, and somewhat broader in the middle. The stomach narrow. The intestine appeared at the surface of the liver behind the middle of that organ, was about 5.5 mm. long, reaching to the second fifth of that organ. The reflected part was about 14.0 mm. long, and the alimentary cavity was empty.

The liver 14.0 mm. long, reaching 6.0 mm. in breadth and 5.3 mm. in height. The posterior end rounded, somewhat pointed, more than half the right anterior portion flattened for the anterior genital mass. The surface was grayish-yellow, the substance deeper yellow. The *vesica fellea* smaller than in the typical species, appearing at the right side of the pyloric part of the intestine with a rounded upper end about 1.5 mm. in diameter.

The heart as usual. The sanguineous gland whitish, flattened; about 6 mm. long, with a breadth in the posterior half of 3.5 mm., in the anterior of scarcely 2.0 mm., its thickness about 0.5 mm., covering the largest part of the central nervous system. The urinary chamber large.

The hermaphroditic gland yolk-yellow, spread over the forepart of the liver, over the anterior part of its upper side and over the lateral parts of this organ; in its lobules were large oögene-cells. The anterior genital mass large, about 9.5 mm. long, nearly 6.5 mm. high, and 4.5 mm. broad, oval plano-convex. The yellowish hermaphroditic duct issued from about the middle of the applanation on the forepart of the liver, rather strong, swelling into the yellow ampulla that runs in short windings over the left side of the anterior genital mass to its anterior end, the length of the unrolled ampulla was about 9.0 mm., its diameter only 0.1 mm. The spermatoduct with its windings resting on the ante-

rior margin of the genital mass; its first part about 15.0 mm. long with a diameter of about 1.0 mm., yellowish, passing through a slight stricture into the second, which has only half the length and half the diameter and is of a paler color. The penis nearly 4.0 mm. long, and 1.5 mm. in diameter. The glans in the upper end of the cavity having a length of nearly 1.0 mm. (fig. 17); the cuticula clothing the inside of it seemed to present hooks similar to those in the typical species, but fewer and thinner (fig. 18). The *spermatheca* spherical, about 3.0 mm. in diameter; its duct as usual. The spermatocysts spherical, about 1.6 mm. in diameter. The ducts as usual, the cavity filled with sperma. The mucus gland large, whitish, and yellowish-white; on the anterior part of the left side was a yolk-yellow mass, the large cavity empty. The spoon-shaped lobe in the vestibulum had a length of nearly 2.0 mm.

Since the above observations were made two other individuals of the same species have come under my notice. They were obtained by Dall in September, 1872, at Coal Harbor, Shumagin Islands, Alaska, on a muddy beach at low water. The color of the living animal was "bluish."

The specimens in spirits were 8.0 and 14.0 mm. long, 6.0 and 10.0 mm. broad, 3.5 and 5.0 mm. high respectively, and of yellowish color. The form as above.

The opening of the retracted gill transversely oval, as above mentioned, the gill with 8-9 leaves. The anal papilla as above. Both specimens were dissected.

The central nervous system, the eyes, the otocysts, and the skin



The salivary glands, the œsophagus, the stomach, and the intestine as above. The liver was in length 8.5, in breadth 4.25, and in height 4 mm.; the applanation on the right anterior part shorter than above. The *vesica fellea* as above. The sanguineous gland and the urinary chamber as above.

The hermaphroditic gland with its yellow lobes clothing the largest part of the fore-end and the upper side of the liver. The anterior genital mass about 4.5 mm. long, 3.0 in height, and 2.0 mm. broad. The ampulla of the hermaphroditic duct as above, also the spermatoduct and the penis, which was about 2.0 mm. long. The glands short, its opening and interior clothed with an armature; this last only extended over a total length of about 0.8 mm.; the books (fig. 18) pale yellowish, as above, rising to a height of about 0.016 mm. The spermatheca and spermatocysta as above, and also the spoonshaped lobe in the vestibulum.

Note. Should the reader find any errors of proof-reading in the preceding paper, he will bear in mind that Dr. Bergh has not been able to correct the proofs in person and make due allowances, though it is hardly necessary to remark that the utmost pains have been taken to avoid any such errors.—
H. D.

EXPLANATION OF PLATES.

An asterisk denotes that the drawing is by camera lucida, the fraction denotes the magnification.

PLATE I.

Acridia papillosa (L.) var. *Pacifica*.

1. Mandible from the inside,* $\frac{1}{1}''$; *a*, *crista connectiva*; *b*, *processus masticatorius*.
2. Part of the masticating edge,* $\frac{1}{1}''$.
3. Two teeth from the radula,* $\frac{1}{1}''$.
4. Another from the side,* $\frac{1}{1}''$.
5. Penis; *a*, *ductus ejaculatorius*.
6. Cnidæ,* $\frac{1}{1}''$.

***Fiona marina* (Förskal) var. *Pacifica*.**

- 7. Two teeth from the radula from above,*** $\frac{1}{2}$ ".
*** 4x.**

Hermisenda opalescens (Cooper).

9. Mandible,* $\frac{55}{1}$; a, *crista connectiva*; b, *process. mastic.*
 10. Part of the masticating edge;* a, superior (anterior) part; b, posterior part, $\frac{550}{1}$.
 11. Inferior margin of the hook of a tooth,* $\frac{250}{1}$.
 12. Cnidæ,* $\frac{150}{1}$.

Coryphella sp.

13. Hind part of masticating edge from the inside;* a, posterior part, $\frac{550}{1}$.
 14. Part of the radula;* aa, lateral teeth, $\frac{550}{1}$.

Flabellina iodinea (Cooper).

15. Anterior part of the posterior third of the masticating edge,* $\frac{550}{1}$.
 16. A lateral tooth, from the side,* $\frac{550}{1}$.
 17. A lateral tooth,* $\frac{250}{1}$.

Dendronotus purpureus, Bergh.

18. Elements of the prehensile collar,* $\frac{750}{1}$.
 19. Part of the middle of the collar,* $\frac{750}{1}$.
 20. Elements of the posterior part of the collar,* $\frac{750}{1}$.

Dendronotus Dalli, Bergh.

21. Exterior part of a row of teeth;* a, outer tooth, $\frac{150}{1}$.

PLATE II



Dendronotus Dalli, Bergh.

The tongue and its muscular mass (*c*) from the side; *b*, radula;
c, *tectum radulæ*.

The same from above; *a*, superior end of the radula; *bb*,
muscular masses of the tongue; *c*, end of the descending
sheath of the radula.

Anterior rhachidian tooth, from above,* $\frac{100}{1}$.

The same, from below,* $\frac{100}{1}$.

Dendronotus arborescens (O. F. Müll.).

Hinder part of the cutting edge;* *a*, youngest part, $\frac{350}{1}$.

Hook of a rhachidian tooth,* $\frac{350}{1}$.

A group of (5) follicles of the hermaphroditic gland, *a*, efferent
duct,* $\frac{100}{1}$.

Flabellina iodinea (Cooper).

Part of three rows of plates, from above;* *a*, rhachidian
b, lateral plates, $\frac{350}{1}$.

PLATE III.

Dendronotus arborescens (F.).

Four lateral teeth;* *aa*, doubled tooth, $\frac{350}{1}$.

Dendronotus Dalli, Bergh.

The left mandible from the inside;* *a*, *crista connectiva*; *b*,
superior process; *c*, *processus masticatorius*, $\frac{55}{1}$.

The same with the same lettering,* $\frac{55}{1}$.

A part of the masticating edge,* $\frac{750}{1}$.

Thirteen outer plates of one of the posterior rows of the
radula;* *a*, outermost plate, $\frac{350}{1}$.

A rhachidian tooth or plate from behind, $\frac{350}{1}$.

Dendronotus purpureus, Bergh.

The masticating process;* *a*, the point, $\frac{100}{1}$.

Median plate from the upper side,* $\frac{350}{1}$.

Two median plates from the under side,* $\frac{350}{1}$.

The serrations of the right side of the median plate,* $\frac{750}{1}$.

Three lateral plates,* $\frac{750}{1}$.

1. (*a*) Anterior part of the salivary gland;* *b*, duct, $\frac{100}{1}$.

Tritonia tetraquetra (Pallas).

13. *aa*, the foot; *b*, the corner of the frontal veil; *c*, margin of the genital opening; *d*, penis with the opening of the mucus gland under its root.
14. A branchial leaf or plume.
15. *a*, the anal papilla; *b*, the renal pore.
16. Part of the cutting edge of the *processus masticatorius*, $\frac{25}{1}$.

PLATE IV.

Dendronotus arborescens (O. F. Müller).

1. Masticating edge of the jaw, posterior end, * $\frac{250}{1}$.
2. Elements of the prehensile collar, * $\frac{250}{1}$.
3. Point of the penis; *a*, orifice, * $\frac{250}{1}$.
4. Penis; * *d*, vas deferens; *b*, point of the organ, $\frac{25}{1}$.

Tritonia tetraquetra (Pallas).

5. Part of the cuticle of the frontal veil.
6. The buccal ganglia, with *b* the right gastro-oesophageal ganglion, * $\frac{25}{1}$.
7. The mandibles from in front; * *a*, articulation; *b*, *processus masticatorius*.
- 8, 8. Teeth from the middle of the radula, parts of three rows, seen obliquely from above; * *aa*, median teeth; *bbb*, first laterals from the left side; *cc*, same of the right side; *dd*, second laterals of the left side, $\frac{250}{1}$.

9. Lateral teeth from the middle of a row, * $\frac{1}{2}$.

Middle part of a row;* *a*, rhachidian with 12 laterals; *b*, twelfth lateral, $\frac{350}{1}$.

Diaulula Sandiegensis (Cooper).

Papillæ of the back.

Outer part of two rows of teeth with 6–8 teeth;* *aa*, outermost teeth, $\frac{350}{1}$.

Inner part of two rows;* *aa*, first teeth, $\frac{350}{1}$.

Diaulula Sandiegensis (C.) var.

Two innermost teeth,* $\frac{350}{1}$.

7. Outer part of two rows with 5 and 2 teeth;* *aa*, outermost, $\frac{350}{1}$.

a, first part of the spermatoduct; *b*, prostate; *c*, spermatoduct; *d*, penis; *e*, *vestibulum genitale*.

Penis opened with the glans and spermatoduct.

Lamellidoris bilamellata (L.) var. *Pacifica*.

Dorsal papillæ,* $\frac{100}{1}$.

Akiodoris lutescens, Bergh.

Dorsal papilla,* $\frac{100}{1}$.

Spicula from the rhinophoria,* $\frac{350}{1}$.

Glans penis from the side.

Glans penis from the end.

Cadlina repanda (A. & H.).

Lateral tooth from behind,* $\frac{750}{1}$.

PLATE VI.

Akiodoris lutescens, Bergh.

Median part of a row of teeth;* *a*, rhachidian; *bb*, first lateral; *cc*, second lateral; *d*, third lateral, $\frac{350}{1}$.

The rest of the same row;* *e*, the fourth tooth; *f*, the thirteenth, $\frac{350}{1}$.

The rhachidian tooth, obliquely,* $\frac{350}{1}$.

a, first, and *b*, second lateral teeth from one side,* $\frac{350}{1}$.

First tooth, anterior margin, from above,* $\frac{350}{1}$.

a, first, and *b*, second tooth from behind,* $\frac{350}{1}$.

- 7, 8. Third and fourth teeth from beneath,* $\frac{222}{1}$.
 9, 10. Fourth and fifth teeth obliquely from the side,* $\frac{222}{1}$.
 11. The fifth tooth from above,* $\frac{222}{1}$.
 12, 13. The seventh and eighth teeth from below,* $\frac{222}{1}$.

Akiodoris lutescens, Bergh, var.

14. Rhachidian tooth from below,* $\frac{222}{1}$.
 15. First lateral tooth of two rows,* $\frac{222}{1}$.
 16. The sixth tooth from one side,* $\frac{222}{1}$.
 17. *a*, the ventricle; *b*, the proceeding intestine; *c*, the biliary sac; *d*, the liver.
 18. *a*, yellowish part of the spermatoduct; *b*, thinner continuation; *c*, penis; *d*, duct of the spermatotheca; *e*, vagina of vestibulum.
 19. *a*, spermatotheca; *b*, spermatocysta; *c*, long duct of the mucus gland; *d*, duct of the vagina, directly continuous with *d* of fig. 18.
 20. Longitudinal section of the wall of the glans penis;* the hooks partly broken off and their sockets naked, $\frac{100}{1}$.

Cadlina repanda (A. and H.).

21. Spoon-shaped process of the upper part of the vestibulum from below.
 22. The same from above.

PLATE VII.



7. Similar covering with well preserved "palisades,"* $\frac{1.00}{1}$.
8. Elements of the same,* $\frac{2.50}{1}$.

Cadlina repanda (A. and H.).

9. Elements of the buccal plate from above,* $\frac{7.50}{1}$.
10. The same from the side,* $\frac{7.50}{1}$.
11. The median part of the radula;* *a*, median tooth; *bb*, first laterals, $\frac{7.50}{1}$.
12. The same with four median teeth,* *a* and *b*, as above, $\frac{7.50}{1}$.
13. A median tooth,* $\frac{7.50}{1}$.
14. Third lateral tooth from the side,* $\frac{7.50}{1}$.
15. Outer part of four rows, with one to three teeth;* *a*, outermost tooth, $\frac{7.50}{1}$.
16. Median part of the radula from below;* *a*, median teeth, $\frac{2.00}{1}$.
17. *a*, pyloric part of the intestine; *b*, the *vesica fellea*; *c*, lobes of the hermaphroditic gland.
18. Everted glans penis;* *a*, continuation of the armed cuticle of the anterior part; *b*, interior of the spermatoduct, $\frac{1.00}{1}$.

Cadlina Pacifica, Bergh.

19. The anal papilla.
20. Anterior part of the salivary gland; *a*, duct.

PLATE VIII.

Akiodoris lutescens, Bergh.

1. Part of the radula with three to six rows of teeth;* *a*, rhachidian tooth; *b*, first lateral; *c*, second; *d*, third; *e*, fourth, $\frac{2.50}{1}$.
2. The remainder of these three rows of teeth;* from *a*, the fifth, to the twelfth and outermost tooth, $\frac{2.50}{1}$.

Cadlina repanda (A. and H.).

3. The seventeenth to the twentieth teeth of two rows,* $\frac{1.50}{1}$.
4. The outermost teeth of seven rows,* $\frac{2.50}{1}$.
5. Part of the glans penis,* $\frac{7.50}{1}$.
6. Some of its isolated hooks,* $\frac{7.50}{1}$.

Cadlina Pacifica, Bergh.

7. Elements of the lip-plate or buccal plate.
8. The same in another part,* $\frac{750}{1}$.
9. Three rhachidian teeth,* $\frac{750}{1}$.
10. Median part of the radula;* *a*, median plates; *bb*, first laterals;
c, fourth lateral, $\frac{750}{1}$.
11. Side view of a lateral tooth from the outer side,* $\frac{750}{1}$.
12. The same from the inner side,* $\frac{750}{1}$.
13. Largest lateral tooth,* $\frac{750}{1}$.
14. Outer plates (teeth) of four rows;* *aa*, the outermost, $\frac{750}{1}$.
15. Four outer plates of one row;* *a*, the outermost, $\frac{750}{1}$.
16. Part of the cuticle with its spicula,* $\frac{850}{1}$.
17. The glans penis,* $\frac{100}{1}$.
18. Part of the penis,* $\frac{750}{1}$.

Jorunna Johnstoni (A. and H.).

19. Lateral tooth,* $\frac{250}{1}$.

ON A NEW GENUS AND SPECIES OF SCOMBRIDÆ.

BY W. N. LOCKINGTON.

Since D. W. B. Ayres, between the years 1854 and 1863, described nearly seventy species of fishes from the West Coast of N. America, principally from the neighborhood of San Francisco, until my own scattered notes appeared in the Proc. Cal. Acad. Sci. 1876, very little has been done in ichthyology by naturalists resident on this coast. In 1863-1864, Dr. J. G. Cooper, at that time attached to the Geological Survey of Cal., described eight species; and about the same time Mr. A. Garret, during a visit to this coast, described a Murænoid fish in a paper principally devoted to the fishes of the Sandwich Islands. All these papers were published in vol. iii. of the Proc. Cal. Acad. Sci.

Meanwhile the ichthyology of this coast has received careful attention from Gill, Günther, and Steindachner, the last of whom visited us with the Hassler Expedition, resided here a short time, and took away with him numerous specimens.

It has for some time been my endeavor to collect together and identify such of the species described by the above authors, and by Girard in vol. x. of the Pac. Rail. Reports, as occur in or near the Bay of San Francisco, and to add to our knowledge of them whatever information I can collect respecting their distribution, life-colors, variations, etc.

In so doing I have met with the following new form.

CHROMITRA, nov. gen.

Body elongate, fusiform, cleft of mouth wide. First dorsal separated from the second by an interspace, seven or more spurious fins behind dorsal and anal. No corselet or pectoral region, body naked or covered with small scales. Teeth of moderate strength in the jaws, none on the vomer or palatines. A longitudinal keel on each side of tail. Seven branchiostegals. Dorsal spines 15. Pectoral fins inserted at the level of the eye. This genus is distinguished from *Scomber* by the greater number of the finlets, and by the want of a uniform covering of scales; from *O.* and *Sarda* by the absence of a corselet, and the

interval between the two dorsals; from *Cybius* by the latter character; and from all these genera by the absence of teeth on either vomer or palatines. From *Auxis* it differs in the absence of a corslet, in the larger size of the teeth, and in the greater number of dorsal spines. Etymology, *spina want*, *perpa stomacher*, viz., corslet.

Chromitra concolor, sp. nov.

D. 15 17, VII. A. 1 17, VIII.

Teeth in a single row, triangular, compressed, those of lower jaw largest, none near the symphysis. Seven or eight finlets behind the dorsal, eight behind the anal; pectoral one-eighth of the total length to the end of the central caudal rays, ventrals small, in length less than $\frac{1}{4}$ th of the pectorals.

Description.—Dorsal outline a regular gentle curve from snout to tail, ventral outline similar to that of dorsal.

Cleft of mouth slightly oblique, maxillary reaching to a vertical from the hinder margin of the eye; its anterior part concealed behind the preorbital when the mouth is closed.

Jaws equal in front, teeth in a single row on the jaws, none on the vomer or palatines. Teeth in lower jaw larger than those in upper, compressed at base, gently curved inwards; those in upper jaw much smaller, compressed, triangular, straight.

Length of head slightly exceeding the greatest depth, and contained about five times in the total length.

Eye slightly oval, its longitudinal diameter contained seven times in the length of the head. Snout a little more than one-third

All the spines are exceedingly slender and fragile; the longest are about equal to one third the length of the head.

Interspace between the two dorsals about one-fourth of the length of the base of the first dorsal.

Second dorsal commencing half way between the tip of the snout and the origin of the caudal, increasing rapidly in height to the fourth, which is equal to the sixth, and slightly shorter than the fifth, the fifth a little less than half the length of the head. The rays diminish rapidly in height to the eleventh, which is about half as long as the fifth, the remaining rays decrease slowly to the last, which simulates a finlet.

Anal similar in form to second dorsal, but its rays somewhat shorter than the corresponding dorsal ones.

Pectoral pointed, the rays diminishing very rapidly from the fourth to the eleventh from its upper margin; the 11th to 15th rays nearly equal, remaining rays very rapidly shortening. Centre of base of pectoral in a line with a line drawn from the tip of the snout through the centre of the pupil.

Ventrals very small, less than two-fifths as long as the pectorals.

Length of inner side of upper lobe of caudal a little less than $\frac{1}{4}$ th of the length of the fish (to end of middle caudal rays), lower lobe slightly shorter. Lateral line diverging gradually from the dorsal outline as far as the origin of the second dorsal, where it lies slightly below the upper third of the height, thence curving downwards rapidly to a vertical from the front of the first dorsal finlet, thence in an undulating line along the centre of the depth to the caudal keel.

A low keel, convergent posteriorly, above and below the central keel of the caudal peduncle.

Long narrow scales on the region behind the eye, along each side of the dorsal outline, and on the peduncle of the tail, remainder of body naked.

Color of the upper portions dark steel blue, becoming silvery below, no streaks.

The specimen in the possession of the Cal. Acad. of Sciences was obtained in San Francisco Market, and was probably taken, as were previously examined specimens of this species, in Monterey Bay. It is said to occasionally straggle as far north as San Francisco, or even Tomales Bay.

	Inches.
Total length to end of middle rays of caudal	21
Length of head	4½
Greatest depth of body about	4½
Longitudinal diameter of eye	½"
Length of snout	1½
Width between orbits	1½
From tip of snout to origin of first dorsal	4½
Length of base of ditto	4½
From tip of snout to origin of second dorsal	10½
" " " anal	11½
Length of pectoral	2½
Length of upper lobe of caudal, along posterior margin	3½
Length of ventrals	1"

APRIL 1.

The President, Dr. RUSCHENBERGER, in the chair.

Forty-two persons present.

The death of Geo. B. Wood, M.D., a member, was announced.

On Hybrid Fuchsias.—Mr. THOMAS MEEHAN exhibited a seedling fuchsia which had been obtained from *F. syringaeflora*, that had been pollenised by a garden hybrid named "Inimitable." Mr. M. detailed the precautions taken to avoid the use by the flower of its own pollen. This one exhibited was the only one that had foliage and habit exactly like its female parent, and the flowers were also alike in every particular. The five remaining had not yet flowered, but were more or less unlike the female parent, and unlike each other in appearance. The foliage of one yet to flower was very much like the male parent; and one plant which had been destroyed by an accident last summer was exactly like the male parent.

The chief point of interest was that the pollen from one single flower, operating in one single pistil, and resulting in one single berry, should produce such a dissimilar progeny.

Note on the Adoption of an Ant-Queen.—Mr. McCook reported the following case of the adoption of a fertile queen of *Crematogaster lineolata*, a small black ant, by a colony of the same species. The queen was taken in Fairmount Park April 16th, and on May 14th following was introduced to workers of a nest taken the same day. The queen was alone within an artificial glass formicary, and several workers were introduced. One of these soon found the queen, exhibited much excitement, but no hostility, and immediately ran to her sister workers, all of whom were presently clustered upon the queen. As other workers were gradually introduced they joined their comrades until the body of the queen (who is much larger than the workers) was nearly covered with them. They appeared to be holding on by their mandibles to the delicate hairs upon the female's body, and continually moved their antennae caressingly. This sort of attention continued until the queen, escorted by workers, disappeared in one of the galleries. She was entirely adopted, and thereafter was often seen moving freely, or attended by guards, about the nest, at times engaged in attending the larvae and nymphs which had been introduced with the workers of the strange colony. The workers were fresh from their own natural home, and the queen had been in an artificial home for a month. As ants the workers of different nests are usually be

other, this adoption of an alien queen is an example of the strong instinct which controls for preservation of the species.

APRIL 8.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-five persons present.

APRIL 15.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-three persons present.

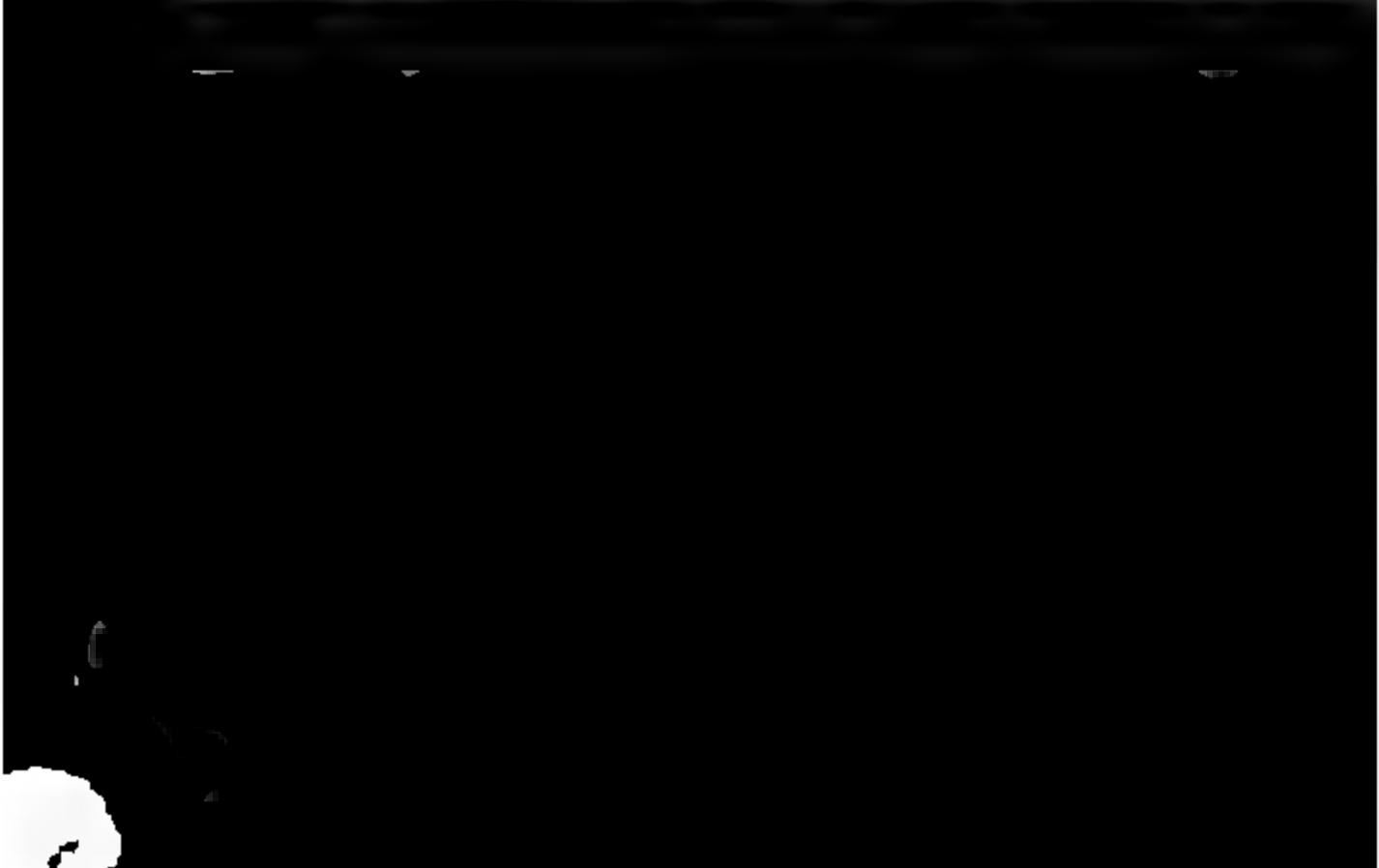
The following papers were presented for publication:—

“Placenta of *Macacus Cynomolgus*.” By H. C. Chapman, M.D.

“Description of a new species of *Chirocephalus*.” By John A. Ryder.

The death of Isaac Hays, M.D., a member, was announced.

On Special Fecundity in Plants.—At the meeting of the Botanical Section, Mr. THOMAS MEEHAN exhibited specimens and remarked on the curious fact that special fecundity was not confined to individuals of any one species of plants, but the species themselves often exhibited peculiar fertility, as other species again were characterized by an indisposition to produce seed. Occasionally whole families or natural orders of plants exhibited these peculiarities. In our green-houses the *Begonia*, which has male and female flowers separately on the same plant, some species had



APRIL 22.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-seven persons present.

Notice of a New Pauropod.—Mr. J. A. RYDER described a new myriapod which he had recently discovered, and which turned out to be nearly allied to the form described by Sir John Lubbock under the name of *Pauropus*. The specimens which the speaker had obtained were five in number, and had but six segments, fewer than any other known member of the group, whilst the number of pairs of legs was nine, the same as in *Pauropus*, which is very strong evidence that the specimens are adults. The following characterization of the genus and species was proposed:—

Eury-pauropus spinosus, gen. et sp. nov. Body segments six in number, sixth exceedingly rudimentary; antennae five jointed; legs in nine pairs, equidistant; tergal sclerites laterally expanded so as to conceal the legs almost entirely when the animal is viewed from above, and covered with fine tubercles which are joined to each other by raised lines; appressed curved spines are also scattered over their surface in less number, and also fringe their margins, being disposed at regular intervals; the spines and lines give the dorsal surface of the little creature a slightly silky lustre when viewed with reflected light. Color a delicate light brown. Mouth-organs the same as in the first-described genus. No evidence of eyes could be detected. Length $\frac{1}{2}$ th of an inch; width about $\frac{1}{4}$ th of an inch. Habitat in Fairmount Park, Philadelphia, east and west of Schuylkill, under decaying wood.

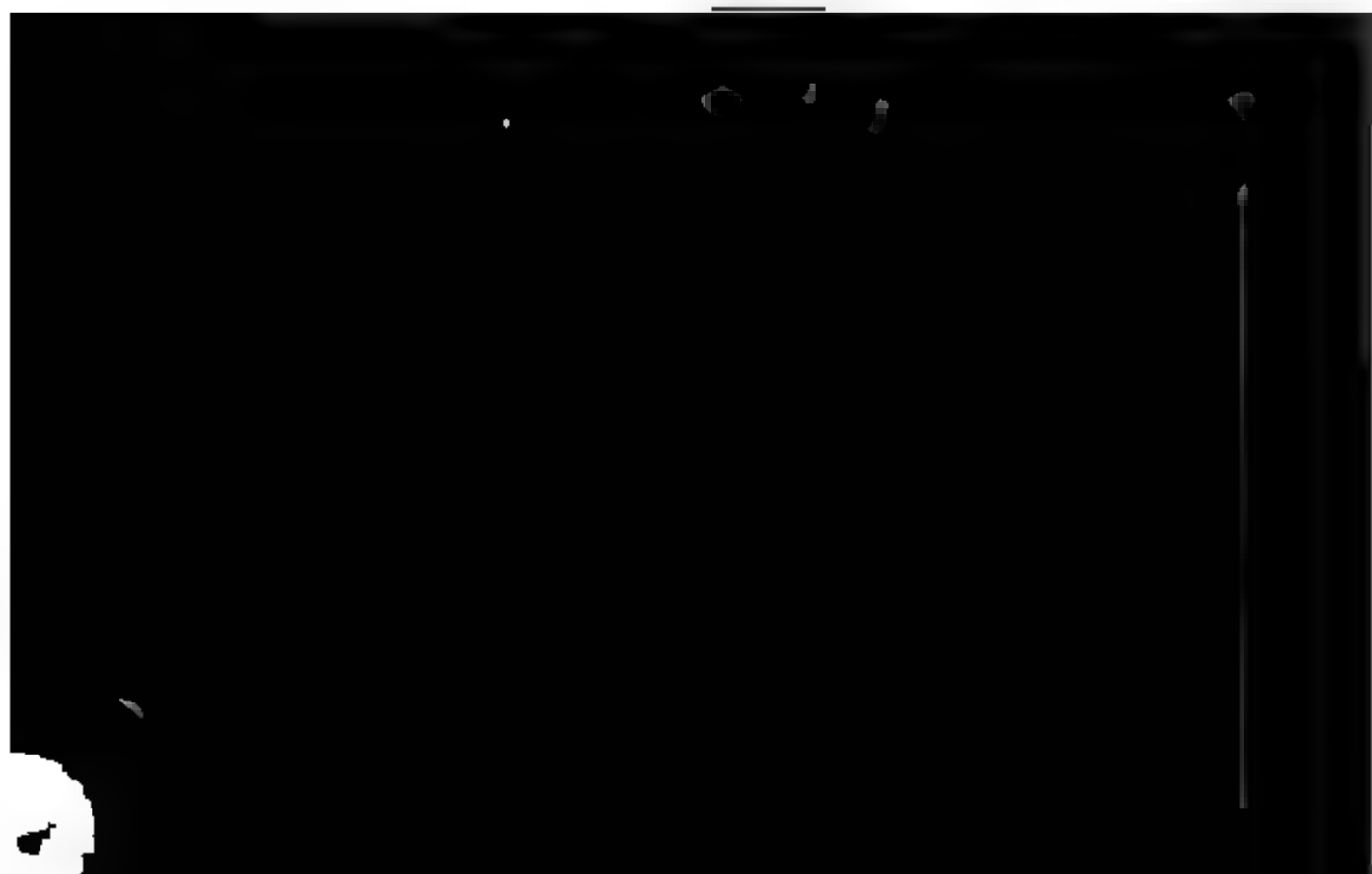
The tergal sclerites are much thicker than in *Pauropus*, having the characteristic brown color of chitin when viewed with transmitted light. The antennae have the terminal globular hyaline body with a long pedicle as in *Pauropus pedunculatus*. The type is the most distinct form discovered since the detection of the first known representatives in England in 1866, and also extends the geographical range of the family, and does much towards fully establishing the *Pauropoda* as a distinct order of myriapods.

Do Snakes Swallow their Young?—Mr. MEEHAN remarked that European zoologists yet seemed incredulous that young snakes would enter their mothers' mouths for protection when frightened. He had witnessed such an occurrence, but it had been suggested that his eyes deceived him. Professor Brown Goode had collected evidence sufficient, he thought, for American zoologists to believe in. Similar facts came to us from Australia. He read a paper better to himself from Baron Ferdinand Von Muell.

bourne, stating that two observers, whom Dr. M. believed perfectly credible, had, independently of each other, witnessed similar protection in that country.

Dr. Kenderdine said he had personally seen a case where a garter snake so protected its young.

Mode of Depositing Ant-eggs —Mr. McCook stated that a queen of the black carpenter ant, *Camponotus Pennsylvanicus*, which had long been kept in an artificial nest, had once been seen in the act of depositing an egg. The queen was at the time clinging to the side of a hollow in the surface of the earth, almost in a vertical position. The usual body-guard of workers quite surrounded her, continually touching her with their antennæ. The egg was a white cylindrical object, about one-eighth of an inch in length. It was about two minutes in escaping from the body, and as soon as dropped was carried below within the galleries by a worker. The queen was never left by her body-guard, who sought to control her movements by pressing around her, blocking up the path which she wished to take. Frequently more vigorous persuasions were used, an antenna or leg being grasped by a worker, and the queen thus pulled backward. She made no attacks upon her guard, but often stubbornly held her own way; though commonly yielding more or less graciously to her attendants. This colony had been received from the Allegheny Mountains in December, within their formicary in an oak bough, in which they were hibernating, being quite stiff with cold. They immediately revived in the warmth, and were healthy and active during the following spring. The queen survived until September following, and would doubtless have lived longer had she not been neglected during a prolonged absence in summer. She outlived all her subjects, and was certainly more than a year old.



located directly in and on the grassy border of a trodden path in a farmyard. At 4 P. M. the males and females were seen coming out and re-entering the gate, amid great excitement on the part of the workers. The females particularly were followed by workers who "tensed" them occasionally by gently tapping them with their mandibles. The flight of the young queens was, with few exceptions, made from the top of stalks of grass, where they clung for several minutes, posing themselves, spreading their wings, and waving up and down. Even to these elevations the workers followed them, hastening their flight by occasional "nips." When the queen rose in flight, there was no evidence of feebleness or hesitancy, except, in some cases, a slight tendency to a zig-zag course for the first few yards. The flight was then, and in most cases from the very first also, strong and in a straight course. The insect first rose to a height of about 20 feet, which was soon increased to 40, 50, and even 60 feet (estimated), and this latter height was maintained until the form was lost to sight. He was able to follow the ants in several instances to a distance of more than 100 feet, before they disappeared, at which time they gave no sign of alighting. Some were seen to alight at the distance of 50 and 80 feet, others flew into a large buttonwood tree within 20 feet of the nest.

The flight was in every case solitary, and was in all directions, although generally in the direction of the breeze. The males were at the same time constantly taking flight, urged thereto by teasing workers, each separately, and wholly independent of other males and of the females, as to the time and direction of flight. This fact led Mr. McCook to infer that the pairing of the sexes must have occurred within the nest before departure therefrom, except in the case of those individuals who lit upon the buttonwood tree, there appearing no opportunity for a meeting after flight. There was nothing in all the facts to suggest the idea of a former consort. The same feature of independent and solitary flight of the sexes had been observed in the swarming of the Shining Sawmaker *Polyergus lucidus*. This is in marked contrast with the habit of some other ants as illustrated in an observation subsequently given.

Before taking flight the *L. flavus* females spent some time in combing and cleansing themselves. A female was pined among the workers of another nest not more than a yard distant from her own, in order to test the treatment of an alien. She was immediately attacked fiercely, and would no doubt have been soon killed had she not been removed. In two former instances from which the above marriage flight occurred, it was observed that the doors were closed about 4 P. M. by beds of dry grass and pellets of soil. They so remained during the night, or at least were found so closed in the morning. Three days thereafter several males were found wedged under a chip by the roadside. As soon as the chip was

turned up, two of these were seized by a couple of prowling ants of the species *Tetramorium exspitum* and *Formica Schauffussi*, and carried off as prey, a suggestion of the common fate of emmet masculines.

His attention had been called to an article in a Hollidaysburg (Pennsylvania) journal, which reported a remarkable swarm of ants that had crossed that town on the 13th September, 1876. He immediately wrote to Rev. D. H. Barron, a citizen of the place, and a gentleman of intelligence and prudence, giving certain points which it was desirable to ascertain. The ants in the course of their flight had come in contact with the mechanics at work upon the tower of the new court-house, whom it was reported they had assaulted vigorously. Mr. Barron visited these men, and after a careful interview communicated the following facts. The flight actually occurred substantially as reported; the day was clear, warm, and calm; the ants came between 10 and 11 A. M., from the direction of the Chimney Rocks, a ridge of the mountain on the southeast of the town. As to numbers, the answers of the men were as follows; "so thick you could hardly see through them," "swarms," "about 30,000!" The ants struck the building at the height of about 120 or 125 feet, and certainly assaulted the men. Whether the attack was a bite or a sting they could not tell, but it was something very uncomfortable, and they would not like to have it repeated. The ants were of two sizes, some larger some smaller. One of the men had saved some specimens which were sent to Mr. McCook and proved to be the males and females of *Myrmica lobricornis*, Nylander. These ants can inflict a painful sting, but probably attacked the workmen simply in self-defence, that is, the men happened to obstruct their flight, and naturally vigorously brushed off the insects who lit upon them, who in turn becoming irate applied their stings. Such a vast horde as this swarm contained must have been composed of the winged inmates of many formicaries on the mountain side. This is quite in contrast with the solitary flight of *Lasius flavus* as described in a former note. The pairing of the sexes was probably in the air, or after alighting, as in the case of the agricultural ant. Mr. McCook had taken ants of the same sub-family *Myrmecinae*, while they were in the act of pairing in the air.

In connection with the above notes on the queen-life of ants, he presented an observation reported to him by Mr. Jos. Wilcox. This gentleman had seen a colony of some species of *Camponeatus* occupying a large dead cypress tree standing in the midst of a cypress swamp in Florida, at least 600 feet from the shore. The tree was wholly isolated from the land and from all surrounding vegetation except another fallen cypress tree which leaned up against it. Evidently a fertilized queen had at some time flown from the land to this tree, where she had established the colony.

¹ Agricultural Ant of Texas, p. 143.

The fact is interesting as indicating the origin of formicaries from single queens, as myrmecologists have supposed to be frequently if not commonly the case. Further, as showing the ability of a large number of ants (this nest was reported to consist of vast numbers) to maintain active life under quite circumscribed environment. The insects sheltered in such numbers by old trees may have furnished a large portion of the food supply. The specimens brought by Mr. Wilcox were taken from a colony on the land, which he supposed to be identical with the swamp-tree nest, and were examples of *Camponotus esuriens*, Smith.

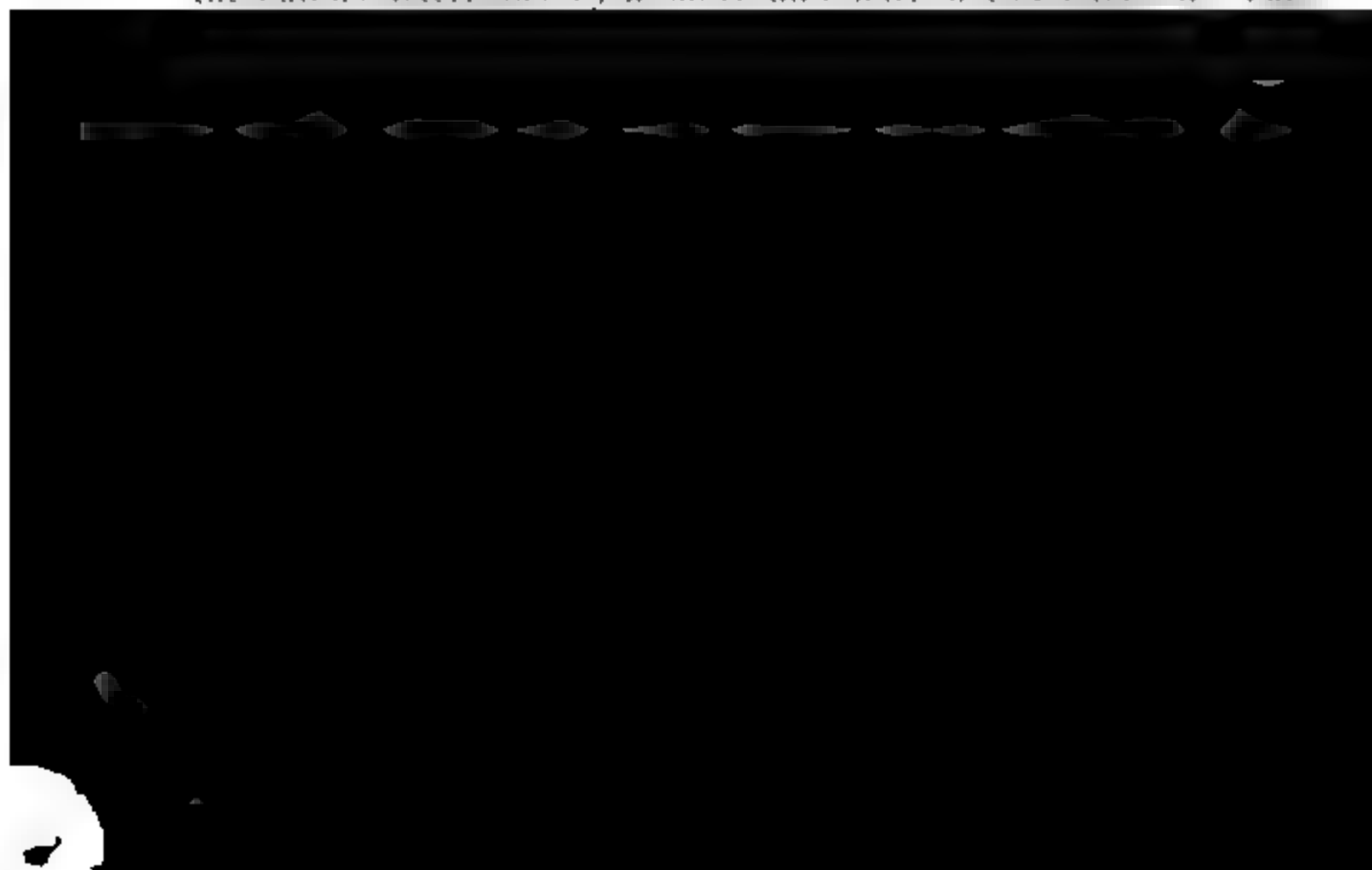
Henry W. Stelwagon, M.D., Henry T. Coates, Wm. S. Magee, James F. Magee, J. J. Kirkbride, M.D., and Robert Meade Smith, M.D., were elected members.

The following were ordered to be printed:—

NOTES ON THE AMPHIUMA.

BY HENRY C. CHAPMAN, M.D.

On looking over general works, like those of Owen, Huxley, Milne Edwards, Gegenbaur, Stannius, etc., in reference to the anatomy of the Perrenibranchiate Batrachia, I find that the *Amphiuma* is only referred to in a general way, and, with the exception of Cuvier's memoir,¹ I do not know of any special paper having been published on the structure of that animal. Having dissected the *Amphiuma* that recently died at the Zoological Garden, I thought that it might not be uninteresting to notice the disposition of its internal organs. The specimen was a male, and measured twenty-nine inches. As regards the alimentary canal, the only difference that I noticed in my specimen, as compared with that described by Cuvier, was that the rectum did not exhibit the constrictions seen in the figure of his specimen. In other respects, such as the longitudinal folds of the stomach, the openings into the cloaca, etc., they were alike. The liver and spleen were large, and there was a distinct pancreas. The lungs were well developed, and attained a length of thirteen inches, which may serve to explain the fact of the animal being able to remain under water such a length of time. The heart differs from that of the siren in that the auricles are not fringed to the same extent. The ventricle is large and muscular, and is separated from the bulbus arteriosus by a short and narrow constriction. The



was long and narrow, measuring nine inches: it opened into the cloaca. I can only account for the great length of the bladder in the *Amphiuma* and *Siren* on the supposition that it represents a sort of rudimentary allantois. This view is strengthened by the fact of the *Amphiuma* having very simple limbs, and in this respect also foreshadowing higher types of life. The uro-genital apparatus in its general arrangement resembles that of the newt (*Triton teniatus*). The testicle, however, was undivided, and measured five and a half inches in length; it was situated in the posterior third of the body cavity. From the testicle six or seven efferent ducts pass transversely outward to the remains of the upper part of the Wolffian body, represented by a chain of dilations. From this embryonic remnant pass about twelve tubes into a common uro-genital duct, which measures nine inches. This duct runs in a wavy course until it reaches the lower part of the Wolffian body, or the so-called kidney. Here the duct becomes straight, and lies on the outside of the Wolffian body, from which it collects, through small tubes, the urine. This common uro-genital duct opens into the cloaca posteriorly to the bladder. I was able by pressing upon the duct to squeeze a considerable amount of semen through its opening into the cloaca, which gave me the opportunity of examining the spermatozoa. These bodies did not exhibit a very well defined head, but one end was obtuse and the other tapered off tail-like. Just between the cloaca and abdominal wall I found coiled up a nematoid worm, which may be the *Ascaris unguiculata*. I found what seemed to be also the same worm in an encysted condition in the intestine and in the mesentery.

PLACENTA OF *MACACUS CYNOMOLOGUS*.

BY HENRY C. CHAPMAN, M.D.

Comparatively little is known concerning the foetal condition of monkeys. In those of the New World (*Platyrrhina*) the placenta is single. As regards the Anthropoids the placentation in the Gorilla and Orang is unknown; in the Chimpanzee the organ is single; in the *Hylobates* it is double. In the remaining Old World monkeys (*Catarrhina*) the placenta is usually described as being double. Thus Prof. Owen observes, "in the tailed *Catarrhina* the placenta is double, the two being distinct and apart."¹ According to Prof. Milne Edwards, "chez les autres singes de l'ancien continent cet organe est divisé en deux lobes bien distincts."² Prof. Huxley states, "that the placenta is often bilobed."³ In the genera *Nasalis*, *Semnopithecus*, *Cercopithecus*, according to Breschet,⁴ and in the *Macacus nemestrinus*, according to Prof. Rolleston,⁵ the placenta is double. In the case of the *Macacus nemestrinus* I have confirmed Prof. Rolleston's observation in two instances. Having recently made a post-mortem examination of a pregnant *Macacus cynomolgus*, which died at the Philadelphia Zoological Garden, of phthisis, I was surprised to find on opening the uterus that the placenta was single, contrary to what might have been expected. As the opportunity rarely presents itself of examining *in situ* the foetus and membranes of a monkey, it appears to me proper to communicate the results of my dissection. In opening

to the membranes, the amnion and chorion adhered and were in contact with the decidua. As the pregnancy advanced, I cannot state whether there was a decidua re- least it was undistinguishable from the decidua vera. In spect the disposition of all the parts strikingly resembled the human being under similar conditions.

DESCRIPTION OF A NEW SPECIES OF CHIROCEPHALUS.

BY JOHN A. RYDER.

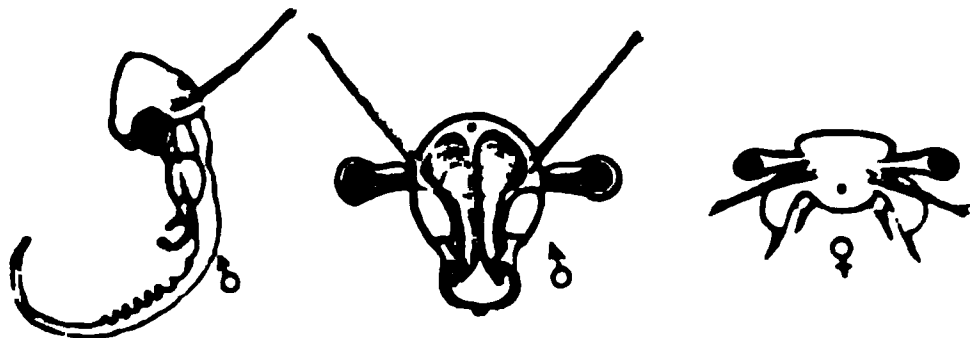
The genus *Chirocephalus* does not seem to have been noticed up to the present time in North America; I therefore take much pleasure in announcing the discovery of a hitherto undescribed species of the genus in the vicinity of Woodbury, New Jersey, where it was found in abundance in the ditches by Mr. W. P. Seal, a resident of the place, and an indefatigable collector of the minute life of his neighborhood.

The genus, as characterized by Dr. Wm. Baird,¹ has been found in Switzerland, France, England, Russia, and Siberia. The species *C. lacunæ*, most nearly like the one I am about to describe, is figured and described by Guérin in his *Iconog. Regne Animale*, as being found at Fontainebleau, France. The differences between our species and Guérin's are, however, sufficiently striking and constant to characterize a well-marked specific type, and I accordingly propose the following specific characterization of the American form.

Chirocephalus helmanli, nov. sp.

Char. specif.—Claspers moderately robust; second joint forked, longest branch longer than first joint, and curved inwards, its tip crossing that of its fellow of the opposite side when in repose; shorter branch less curved, slightly swollen, and rough on the inner surface of its tip, about half as long as the longer branch.

indistinctly the segments of the organ. Total length of the proboscis, when extended, about three times that of the claspers. Total length 12-14 mm. Habitat, Woodbury, New Jersey.



Head of male with probosciform organs uncoiled, from the side. Same, viewed from before, with probosciform organs coiled up and retracted between the claspers. Head of female from above.

I name the above species in honor of Mr. D. S. Holman, Actuary of the Franklin Institute, in recognition of the services he has rendered in devising methods for studying living objects, both large and small, under the microscope, and to whom I am also indebted for the specimens from which the above description has been taken.

The detection of a member of the genus in this country is very interesting, but less so than the detection of *Pauropus huxleyi* Lubbock, in the vicinity of Philadelphia, without any difference, as far as Mr. Lubbock's excellent plates of English specimens would enable one to judge, that would make it even a variety, although removed by more than 3000 miles of ocean from its congeners. It has been suggested, however, that, inasmuch as Philadelphia is an old English settlement, *Pauropus* may have been introduced, but in the case of *Chirocephalus* such an explanation is less open to acceptance.

MAY 6.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-one persons present.

Pairing of Spiders, Linyphia marginata.—Rev. H. C. McCook remarked that on the afternoon of June 14, 1878, he witnessed the pairing of a male and female of *Linyphia marginata* at Bellwood, Blair Co., Penna. The spiders were first observed at a quarter before 4 o'clock P. M. They were hanging inverted in the dome-shaped nest of the species, in line with each other, and about three-quarters inch apart. Each hung within a smaller dome, delicately but perceptibly defined, that rose within the summit. These were perhaps formed by the outspread feet drawing down the inner surface of the dome.

The position of these individuals seeming to indicate the act of copulation, he arranged himself before them as comfortably as possible for observation. The nest was hung from the lower surface of an end of a plank that jutted over from a pile of lumber, about two and a half feet from the ground, so that, seated before the nest, his face was on a level with the spiders. The male reached out one foot cautiously toward the female, pulling upon the threads. He turned a moment to adjust the block on which he sat, and, on again looking, the two were in embrace. The female was suspended in the same position as before, although turned at right angles to the line on which she hung when first seen. The head of the male was laid against the sternum of the female, the abdomen inclined a little upward, the forelegs interlocked with or rather interlaid upon those of the female. Both

gradually contracted and withdrawn within the black corneous bulb, which was meanwhile pressed eagerly against the epigynum. A small elbow or projection upon the upper part of the bulb seemed to press within the spermatheca of the epigynum. The two bulbs were laid simultaneously upon the tubes of the spermathecae, but the inflated sac appeared in but one bulb at a time; the latter action alternated in the bulb. There was a prolonged squeezing motion of the bulbs, as though pressing into the spermathecae, and at times a corresponding motion in the abdomen of the female especially at the apex. With this exception the female remained motionless during the whole period of copulation. After apposition as above the male bulb was slowly, for the most part, but sometimes rapidly, raised, bent upward, and apparently clasped upon the tubes or lower margin of the sac, when parts of course were upward. Three or four movements back and forth in this clasped position followed, when the series of motions above described was repeated.

In the meanwhile the other bulb remained upon the other tube until the first bulb began to descend, when it in turn was elevated, and the same motion made. As the bulb descended the sac began to inflate and issue. The above is the process as it was quite regularly repeated. Sometimes, however, both bulbs were clasped upon the tubes at the same time; sometimes the movements of the bulb were more rapid than at others. The bulbs had the appearance of having been moistened by some secretion, presenting the peculiar gloss which a colorless liquid gives to a black surface, but he could see no secretion otherwise, although he was able at any time to use his pocket lens with the exercise of a little care.

At twenty minutes before 6 six o'clock he was compelled to leave, at which time the pair had been in embrace one hour and forty-nine minutes. At six o'clock twenty-eight minutes he returned, and found the pair in precisely the same positions. He remained five minutes, and then left an intelligent young man at the post, with full instructions as to points of observation. He reported that at thirteen and a half minutes to seven P. M. the pair parted very suddenly. The male ran downward to a portion in the lower margin of the dome pursued by the female, who stopped suddenly just above and turned back to the central point in the summit of the dome. Shortly after receiving this report Mr. McCook visited the nest and found the female suspended motionless in this position and the male at the point to which he had fled, feeding upon a small fly. The next morning at seven o'clock the female was in the same position, and the male had disappeared. He attempted to capture the female, but she ran among the boards and escaped. The pair had thus been in union two hours and fifty-five and a half minutes.

During this period they were separated a number of times.

Nineteen of these interruptions were noted; one was caused by a small fly striking the snare, which the male darted at in a fierce manner, but failed to seize, as the fly broke loose before he reached it. Others were caused by the observer touching the foundation threads or other parts of the nest. Toward the close of his observations he accidentally broke the suspending lines nearest to him and so caused one side of the dome to fall in. This made only a momentary interruption. Many of these separations were, however, apparently without any extraneous cause. Twice the male ran to one side of the dome, made a web attachment to a bit of leaf hanging in the snare, drew out a thread about two and a half inches long, which he overlaid a couple of times, and then made the following motion: First, the body was placed erect, i. e., back upward, and was moved back and forth along the line, rubbing the points or "nippers" of the palps at the same time; then the spider swung over until the body made an angle of about 45° with the line, and while holding on thus the palps were rubbed back and forth alternately along the line as before. The process was repeated during another of the intermissions, as described above. It was conjectured that the purpose of this movement might be the distribution of the seminal fluid into the palpal bulba. This is taken up by the sacs, by the inflation and contraction of whose membranous coats it is forced into the spermathecae of the female.

MAY 13.

WM. S. VAUX, Vice-President, in the chair.

Thirty-three persons present.

The Lateral Sensory Apparatus of Fishes.—Dr. FRANCIS DEB-
CUM called the attention of the Academy to the so-called mys. 619



nerve-buttons, and in which terminates a nerve fibre. He corroborated Leydig's statements regarding the existence of a little mass of viscid mucous or jelly-like matter resting on each disk, and also regarding the positions of the disks, *i. e.*, as generally occurring under small bridges of bone in the canals of the head, and as occurring in every scale of the lateral line. However, the specimens exhibited by him showed a result entirely different from that of Leydig as regards the distribution of the nerves. Leydig pictures the disk as composed of two distinct areas, a dark or less translucent central portion, and a lighter peripheral portion. This appearance is, indeed, simulated in the fresh preparation, as the disk is somewhat transparent, and allows the insertion of the nerve fibre to be seen directly through it. No such appearance, however, is presented in specimens treated by osmic acid. A dense, arborescent plexus of nerve-fibres comes into view, and the distinction into two areas entirely disappears.

The size of the entering nerve as compared with the size of the disk is relatively very great, so that when the dense plexus of nerves makes its appearance it strikes one as though the bulk of the disk were nerve matter. Indeed, besides a large number of capillaries it contains only a small amount of connective tissue.

Owing to the want of the proper material, Dr. Derrien had not been able to confirm the observations of F. E. Schulze on young fishes. However, transverse sections of the disks macerated in osmic acid and teased, yielded essentially the same results as regards the structure of the epithelium. This appears to consist of two kinds of cells, one long and cylindroid, the other small and globose or pyriform, and having long outrunners penetrating the subjacent connective tissue. These outrunners are probably continuous with nerve fibres, which they resemble. The drawings representing the connections of the nerves with the cells, given by F. E. Schulze for the "nerve-hills" of young fishes, are, therefore, very probably correct, but the material at hand did not permit an absolute decision of the point. The hairs of these perceptive cells were readily distinguished, but were generally broken and mutilated, owing doubtless to the reagents and teasing.

As is well known, the canals of the head are generally provided with bony supports, which form grooves, and which are at intervals generally bridged over by bone. Thus certain membranous interspaces of greater or less size are produced. In some fishes, as *Centropomus undecimalis*, the bony bridges are more or less wanting, so that a comparatively large expanse of membrane is formed stretched between the two walls of the canal. These membranes are, of course, composed of two elements. They consist, first, of the delicate connective tissue and flattened epithelium belonging to the canal, and, secondly, of the dense layer of connective tissue and epithelium belonging to the skin. The two layers can be readily separated by a careful dissection. Each

membrane, were it stretched tightly, would form functionally a drum-head. It is, however, quite loose, and will fluctuate readily on pressure.

The function attributed to this apparatus by F. E. Schulze, that these structures appreciate mass movements of the water, and also waves having longer periods than those appreciated by the ear, is no doubt the correct one. However, the canals cannot act in the manner suggested by Schulze, i. e., by allowing the water to flow freely through them, as such a free communication with the surrounding medium as is implied, is not present. As already stated, in some fishes the canals are completely closed along their entire course, and when openings are present, they are probably for the purpose of maintaining an equilibrium of pressure within and without the apparatus.

The true detailed action of these organs is probably as follows: Let us suppose any disturbing cause to set up a wave of long period in the water. It impinges, first, on the membranous interspaces or drum-heads before spoken of, and with the greatest intensity, of course, on those which are most nearly placed at right angles to its direction. The wave is thus communicated to the liquid in the canals, which transmits it to the adjacent masses of jelly-like mucus covering the disks. The quivering of these little masses probably excites and intensifies vibrations of the hairs of the perceptive cells. The fish probably judges of the direction of the disturbing cause by the portion of the apparatus most intensely excited. The membranous spaces or drum-heads, when the apparatus is well developed, are so arranged as to favor the perception of vibrations from almost all directions.

Dr. Dercum suggested that it would be well, in view of the confusion existing in the present names of the dermal structures of fishes, to call these organs definitely the *lateral sensory apparatus* of fishes. This would, of course, not include the sensory ampullæ

large double mound, his attention was attracted by a continuous and peculiar rasping sound. This was produced by ants who were scattered over the surface of the trunk engaged in scooping out with their mandibles the bark thereof. The gray outer bark had been removed in many places, and the reddish-brown bark beneath cut away so as to give the tree a marked spotted appearance. The excavated portions covered a surface at times of two or three square inches, and were from one-sixteenth to one-eighth of an inch in depth. The pellets were sometimes allowed to accumulate in the mandibles, but were generally rejected as soon as cut off, and dropped to the earth. In only two cases was there any application of the tongue to the bark. No other tree was observed to be thus marked. The purpose of this curious behavior could not be conjectured.

The directness with which the foragers take the home path was thus illustrated. One worker was seen by his companion, Mr. Kay, to seize a small green insect, with which she immediately turned homeward. She was followed patiently with her burden to the nest, a distance of 126 feet, and her path upon measurement was found to be a direct line. She was twice attacked upon the route, once by several workers of the same species; she hid from these assailants beneath a leaf and waited until they dispersed. The second time she was assaulted by two workers from whom she escaped by running. Once she rested for one half a minute. A number of times she met foragers apparently of her own nest, for after antennal salutations she passed peacefully on. The direct line was in no case interrupted.

In turning up a number of stones in the neighborhood of various mounds, hosts of white ants, *Termes flavipes*, were uncovered, who were instantly attacked by the roving exsectoides, and carried off in their jaws. These termites evidently are preyed upon by the mound builders. Nests of small true ants, exposed in a similar way, were similarly dealt with.

A great number of abandoned and moss-grown mounds were seen here. In some cases, one part of the hill was occupied and the other abandoned. In the unoccupied parts when washed out by the rains, the exposed walls of the galleries presented a pretty columnar appearance, which was made more striking by the over-covering moss.

As the evening advanced attention was directed to the gates to note if any attempt would be made to close them. Previous studies, made later in the summer, had failed to detect any such effort. Five doors not far removed from each other upon the side of a large mound, were put under close observation. These were watched until the night was too far advanced to allow further notice, at which time, three doors were quite closed and two nearly so. There appeared to be a conflict of behavior on the part of the workers, some carrying the pellets of earth quite out of the

galleries as usual, while others dropped them near the mouth or door. The evening was quite cool and Mr. McCook's impression was that the ants who dropped the pellets within or just outside of the doors were probably caused to do so by the sense of cold with which they were met. Feeling the cold air as they approached the gate, instead of pushing out, they stopped, dropped the pellet, and turned back. Thus the grains accumulated, giving the appearance of an intentional closing. Through the doors which were nearly closed an ant head and antennæ could occasionally be seen peeping forth.

MAY 27.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-four persons present.

Charles H. Pennypacker and Robert S. Davis were elected members.

JUNE 3.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-one members present.

JUNE 10.

The President, Dr. RUSCHENBERGER, in the chair.

Fifteen persons present.

Deaths of Wm. W. Longstreth and F. F. Maury, M

St. Louis, Mo.

ant remained above the surface. The pellet was removed, and the jar thoroughly aired; whereupon the ants speedily began to reappear. They seemed to be confused somewhat by the fumes of the cologne, but soon began to dig galleries. Only two pairs resumed the fight, and these shortly unclasped mandibles. There was no resumption of hostilities thereafter, and the two parties appeared to interblend and fraternize completely.

In the second jar (No. 2), the one exhibited, the ants were left undisturbed. The battle continued for two days. It was waged over the entire surface of the earth within the jar. Every clod and other elevation was the seat of one or more duels, for, as a general rule, the fight was waged by twos, but also frequently by threes. The duelists seized each other by the head, frequently interclasping mandibles, and pulling backward or swaying back and forth. Again, one would have her antagonist grasped by the face above the mandibles, which placed the latter at a great disadvantage. In such cases, and in others also, both ants would be reared upon the hind and middle legs, with abdomens turned under, and stinging organs thrust out. When three ants were battling in one group, the third commonly held her opponent by a leg, or had seized her by the abdomen or thorax. Occasionally the exertions of the combatants caused them to roll upon the ground.

At the close of the first day, numbers had retired from the conflict and perched upon the sides of the jar. On the third day the battle had ceased, and the ants were engaged in excavating galleries. Whether the survivors were all of one party could not be determined, except inferentially by the following experiment.

The jar which had been fumed with cologne (No. 1) was introduced into jar No. 2, which was large enough to admit it. The ants in No. 1, who had been hostile, were then working together harmoniously. They, in turn, soon interblended with those in No. 2, all thus composing one apparently united formicary. It thus appears, whatever may have been the cause of the combat, that, first, the influence of the cologne fumes completely pacified and united the contending parties; and, second, that the previous hostility was no barrier to their forming one harmonious nest. Subsequently the jar was placed uncovered in the open air and was abandoned by all but a few of the ants within two days.

There were many dead bodies, which were gathered in one large heap, that each day was increased by the death of the (probably) injured. This "graveyard" was subsequently changed to another spot, but the dead were kept together as they now are.

In at least one case noted the cause of the ant battle seemed quite clear. The warring insects were spread thickly over a surface of nearly a square foot of the sidewalk, quite near the curbstone. The centre of this struggling mass was a quantity of fatty matter which had been thrown on and around the seams of the

bricks through which a large formicary had made its gates. From the battle field a column of ants, three or four lines deep, stretched along a depression caused by a shallow surface drain to a second nest just under a gate that led through a wall into the house-yard. Evidently the ants from the curb formicary had fallen upon the unctuous treasures which had dropped by their doors, but had been disturbed in their "feast of fat things" by stragglers from the gate nest. The stragglers were attacked; others came, and in time were attacked; messengers ran to the gate nest for reinforcements; fresh squadrons issued from the curb colony, and thus the battle grew. When it was first seen a single line of ants was stretched from battle ground to gate, and a double line from gate to battle field. The ants in these columns were in the utmost agitation. As they hurried along, fairly a-quiver with excitement, they suggested strongly the outward mien and behavior of human beings running to and from a fire, a riot, or a fight. Mr. McCook was not able to watch the issue of this ant battle, but had no doubt that the above is the true theory of its origin. It is probable that many similar conflicts originate in like rivalries for the possession of food.

The system of galleries excavated by these insects is precisely like that of most other mason ants. It is a network of galleries for the most part from one-sixteenth to one-eighth inch wide, but with frequent greatly widened portions. The "meshes" or solid interspaces vary much in size. The galleries were made against the inner surface of the jar, and thus are entirely visible. The ants seemed to have no objection to working in the light. The principal galleries have a tendency more or less regular to the vertical and horizontal, but the impression was made by the mode of operations that the workers were rather influenced by some accidental feature or quality of the soil, than directed by any intelligent plan, in laying out and driving the galleries. The behavior of

The structure of a nest in natural site is obviously more difficult to study. For the sake of comparison, one was taken which was located on the edge of a brick walk. The walk was separated from the grass-plot by a line of bricks set on edge. Several of these and the adjoining flat bricks were removed, thus quite exposing the fomicary to the depth in parts of four inches. The side of the grass-plot against which the bricks had pressed was pierced by many openings, one-quarter of an inch or more in diameter, leading for the most part directly into ovoid chambers whose longest diameters were from three-fourths of an inch to one inch in length. One of the largest of these was close to the surface just beneath the grass roots, and was filled with naked larvæ of worker ants, most of which were white, a few yellow. These chambers had anterior openings extending into the earth. They were united together by galleries, where their boundaries did not interblend. There was an opening directly upward into the grass, but the main avenue for the carriage of excavated earth led downward to the lower edge of the brick, then diagonally upward through the earthen seam of that and the next brick, debouching at the surface and upon the pavement. Openings downward communicated with this avenue, as did also a broad three-eighths inch winding track, which followed the under surface of the brick its entire length, and beyond. These avenues presented the characteristics of those in the artificial nest, but were larger and not so numerous. The large larvæ of several queens were found in the lower avenues.

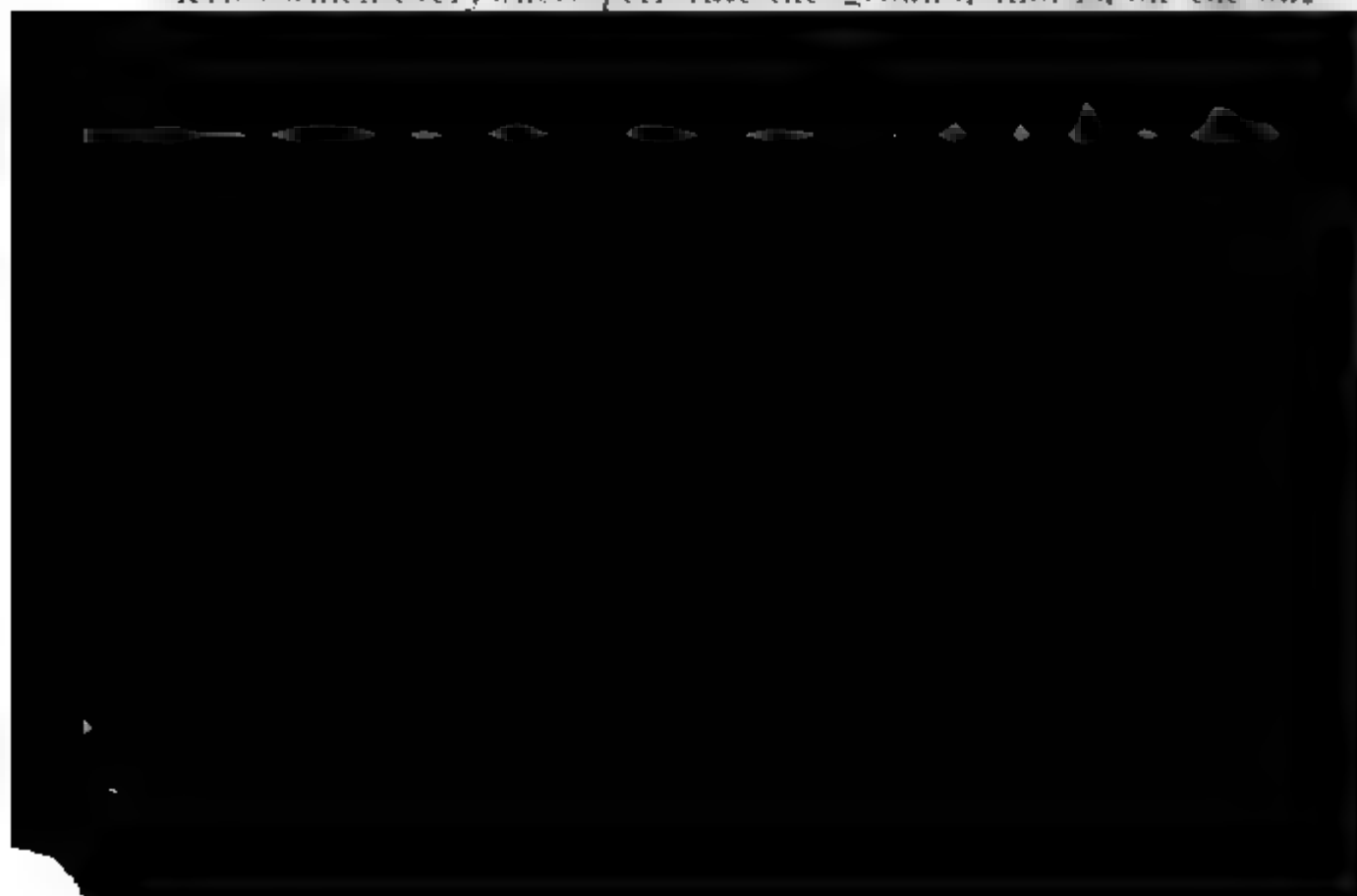
The behavior of the ants placed in jar No. 3 was like that of those in No. 2, *i. e.*, the fighting soon ceased, and the work of gallery digging began. Here, also, it could not be determined whether the survivors were of one party or of both, but the latter was referred in view of the experiment which showed the inter-blending of the harmonized hostiles of No. 1 with the survivors of No. 2. The galleries here were not made against the surface of the glass as in No. 2, but were confined apparently to the interior of the earth, which they must have quite honey combed, as shown by the quantity of pellets brought up, and by the numerous openings upon the surface.

In this connection Mr. McCook referred to the economy in nature of ants by contributing to the fertilization of the earth. A comparison between the fomicaries of various species shows that all the mason ants substantially agree in (at least) subterraneous habitation. The example presented of the underground work of *I. trilineatum* will give some idea of the manner in which the earth may be excavated by a single colony. In a portion of the exposed surface, which presented less rather than more of the average amount of excavation, the gallery surface was measured. In a space of three square inches there were (approximately) one and nine-sixteenths square inches of gallery surface, or **about one-**

half of the measured space. The galleries were in depth fully one-eighth of an inch. This will give a rude notion of the extent to which the underground space occupied by a single colony is excavated.

Another estimate was made of the quantity of earth thrown out of a nest in the two days succeeding a heavy rain. The excavations brought up from the seam of a brick that faced a grass plat, and which were spread along a distance of eight inches, were collected and measured. The result showed a solid contents of six cubic inches. This was only a part of the work of a formicary in the time specified, during only a part of which the ants were engaged in transporting pellets.

The other factor in the calculation is the number of ants of various species spread over any given surface of the earth. Accuracy of count would be quite impossible; but if one will take pains to observe the number of nests which may be seen in nearly every open tract of country, he will be surprised at its vastness. In some such rough observations, made in the open field, Mr. McCook had concluded that it would be scarcely possible to dig within any square foot of surface without uncovering the formicary of some, often of several, species of ants. There is of course a difference in this respect between soils and sections; but the fact is constant that innumerable myriads of ants are everywhere located and operating as above described. As results of such labor, *first*, the ground is pulverized and brought in great quantities to the surface, thus making good top soil for the growth of vegetation. The nest by which these remarks were illustrated shows that, insignificant in size as these insects are, the labors of countless hosts through many years are by no means insignificant in this shifting of the soil. *Second*, the aëration of the soil, so needful for its productiveness, is thus largely promoted. *Third*, the system of "pores," established by the galleries which everywhere perforate the ground, affords, on the one



above referred to showed that it had been penetrated, as far as examined, by the water, as the soil was thoroughly soaked through. The numerous galleries must give more ready access to the rains within formicary bounds than elsewhere. The points are of much interest, and are still under examination, but the following suggestions were made: First, the peculiar arrangement of the galleries and chambers indicates that the least exposed portion of the nest is that near the surface, in the parts which do not communicate directly with the same. The main entrance and exit being removed from this, and penetrating downward and beneath it, would cause a drainage which, carrying off the first flood, would leave the upper chambers comparatively safe until the water should fill up the lower spaces and back up to the surface rooms. Second, it is probable that the galleries which penetrate downwards may serve the purpose of drainage downward. In heavy rains, however, neither of the above arrangements would seem to afford ample protection. Third, it is therefore probable, and observation and some experiments appear to point in this direction, that the ants themselves (if not the larvæ) can endure a submersion more or less prolonged with comparative safety.

Honey Glands on Catalpa Leaves.—Mr. J. A. RYDER stated at the meeting of the Botanical Section that he had recently observed the presence of a number of large nectar-secreting glands on the under side of the leaves of the common *Catalpa bignonioides*. These glands are situated in the axils of the veins of the leaf, *i. e.*, where the lateral veins join the midrib. Those nearest the insertion of the petiole are largest, whilst toward the apex of the leaf they are smaller. The glandular areas, extending over a considerable axillary space as well as to some extent over the sides of the veins, are without hairs, the place of the latter being taken by large, discoid-shaped, sub-circular glandular bodies attached to the surface of the leaf much like a button to a piece of cloth, and projecting above the circumjacent epidermis, though at the point where the gland is attached the epidermis is depressed. The appearance is not much unlike that of the circumvallate papillæ of the base of the human tongue. The glands seemed to be modified hairs, and in thin vertical sections are seen to be composed of columnar cells arranged around a cavity. The nectar observed in a few instances was perceptibly sweet to the taste, and thrown out in sufficient quantity to be seen as small clear drops in the axils of the veins. Ants of both red and black species were seen feeding upon this sweet liquid with great avidity.

See a brief paper on the Vital Power of Insects, Proc. Acad. Nat. Sci. Phila., 1877, p. 134.

JUNE 17.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-eight persons present.

The death of Wm. Adamson, a member, was announced.

On Rhizopods occurring in Sphagnum.—As an instance of the abundance of Rhizopods frequently found together in Sphagnum, Prof. LEIDY stated that he had recently collected some from a cedar swamp near Malaga, Gloucester County, N. J., and in the water and sediment expressed from a small bunch, he had observed the following forms:—

1. *Diffugia pyriformis*. Var. *a*. with shell of coarse sand; var. *b*. with shell of chitinoid membrane with incorporated diatomes and sand. Occasional.
2. *D. acuminata*. Var. with shell of chitinoid membrane incorporated with variable proportions of diatomes and sand. Occasional.
3. *D. constricta*. Syn. *D. cassia*. Several varieties. Frequent.
4. *D. arcuata*. Shell hemispherical, of yellowish chitinoid membrane, with incorporated sand; mouth trilobate. Occasional.
5. *D. globulosa*. Small forms. Frequent.
6. *D. spiralis*. Rare.
7. *Nebela collaris*. Syn. *N. numata*. Of many varieties, of different sizes and proportions. Some in the structure of the shell related with *Diffugia*. Abundant.
8. *N. flabellulum*. Few.
9. *N. barbata*. Occasional.

20. *Centropyxis aculeata*. Occasional.
 21. *C. ecornia*. Frequent.
 22. *Hyalosphenia papilio*. Not so abundant as usual.
 23. *H. elegans*. Not so abundant as usual.
 24. *Euglypha ciliata*. Frequent. Small ones and some of the larger ones hairless.
 25. *E. cristata*. Frequent.
 26. *E. brachiata*. Occasional.
 27. *E. mucronata*. Occasional. Several without the mucro.
 28. *Azzulina seminulum*. Syn. *Euglypha brunnea*; *E. tineta*. Frequent.
 29. *Sphenoderia lenta*. Syn. *Euglypha globosa*. Frequent.
 30. *S. MACROLEPIS*, n. s. First observed. Small, compressed pyriform, with broad neck. Body on the broader surfaces with a single pair of wide hexagonal plates. Length 0.036 mm.; breadth 0.024 mm. Frequent.
 31. *Cyphoderia ampulla*. Syn. *C. margaritacea*. Rare.
 32. *Trinema enchelys*. Numerous and of much variety. Several of a brown color, as in *Arceia*.
 33. *Placocista spinosa*. Syn. *Euglypha spinosa*. Rare.
 34. *Pseudoliffugia gracilis*. Syn. *Pleurophrys sphaerica*. Oval form. Occasional.
 35. *Clathrulina elegans*. Detached and dead, or in an encysted condition. Few.
 36. *Hyalolampe fenestrata*. Few.
 37. *Acanthocystis* ———? Colorless, and with simple, delicate unforked spines. Few.
 38. *Amphizonella violacea*? A single individual.
 39. *Amoeba radiosa*. Rare.
 40. *Amoeba* ———? Young of *A. proteus*. Rare.
- With the foregoing there were associated many desmids, diatoms, rotifers, anguillulas, etc.

JUNE 24.

The President, Dr. RUSCHENBERGER, in the chair.

Seventeen members present.

Note on Ionas inodora.—Mr. THOMAS MEEHAN exhibited specimens of this Mediterranean plant, an escape from a garden, found growing wild in a swamp in association with *Iris versicolor*, *Oncoclea sensibilis*, and other moisture-loving plants. They had made a growth of near two feet long, and the heads of flowers in all cases had ray florets, with the ligulate portions an inch in length. In garden culture the heads were nearly discoid, the ray petals being almost obsolete, and in De Candolle's description the discoid heads are given as a generic character.

Mr. Meehan also referred to the well known relationship between *Compositæ* and *Umbelliferæ*, and noted the presence of vittæ in the akenes of this plant as a point of agreement between the two orders, uncommon in those of the Composite family.

The Larva of Eurypauropus spinosus.—Mr. J. A. RYDER announced that, in a vial in which he had kept four living specimens of this animal for two months past, he had found a single specimen of its very minute hexagonal larva about one-hundredth of an inch long. It had three segments, and a very rudimentary fourth one, and was of a pale reddish or lilac color; exceedingly compressed, more so relatively than the adults, and with the antennæ bifurcate as in the latter. The specimen in life was almost as wide as long. Remains of the shells of ova were also found in a crevice in the same piece of decayed wood upon which the larva was found, and the adults were seen to get into the same crevice and remain for a day at a time, so that it is fair to infer that they are probably the parents of the larva in question. The finding of this larva places the validity of the species beyond question, and also renders it quite certain that six segments is the normal number in the adult. The ease with which these animals bear confinement for a protracted period gives promise that still other specimens of larvæ may be looked for in the same vial in the course of the season.

Wm. P. Foulke was elected a member.

JULY 1.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty members present.



Williamstown, Pa. The specimen is a mass of coal shale, with foot prints, and was discovered by the donor at the Ellangowan Colliery, in strata between the Primrose and Mammoth veins, in the Mahanoy coal field. Mr. Lorenz remarks that it is of especial interest, as the first specimen of the kind found in the Anthracite coal field. The *Sauropus primarius* of Lea, of which the original specimen is preserved in our museum, was discovered in the umbral red shale, near Pottsville, belonging to the subcarboniferous series.

The specimen before us is an irregular slab, upwards of a foot long and less than half the breadth. The upper surface is obscurely ripple marked longitudinally, and is crossed in a slant by seven tracks, which are in pairs, except one in advance on the right. Three only are complete, the others being imperfect. The four tracks on the right occupy a line of six inches, and are about an inch and a half apart from those on the left. The tracks appear to be single, that is to say, not produced by fore and hind feet together, and no distinction can be detected between impressions of these. The more perfect



impressions exhibit four widely divergent toes, successively increasing in length from within outwardly, excepting that the fourth toe is slightly shorter than the third. A feeble rounded impression of a sole is visible behind the toes. The expanse of the tracks is about an inch. The accompanying outline will give an idea of their form, though the sole comparatively

with the toes is not so distinctly defined. The intervals of the toes appear not to be webbed, or at most are only feebly so.

The impressions are probably those of an amphibian, and perhaps pertained to some salamandroid animal.

As it is customary to refer to fossil foot tracks, as representing the animals by which they were made, under distinct names, it would be proper to designate the present specimen in the same way. In accordance with its discovery in the Anthracite coal field, and from the colliery in which the specimen was found, Mr. Lorenz suggests that it should be called the *ASTHRACOPELLANGOWANENSIS*.

On the Castanea Americana. Mr. THOMAS MEEHAN referred to the flowers of the common chestnut, *Castanea Americana*, and pointed out that the flowers were the products of axillary buds, which, in young trees, would have borne branches. These spikes of male flowers fell off by an articulation in the axils of the leaves soon after the flowers were mature, and it was remarkable that in young trees that had not arrived at bearing condition, the buds also fell by an articulation before developing the axillary branch-let. Sometimes the leaves would be considerably advanced before

the disarticulation occurred. Chestnut branches several years old would be found full of these scars where the buds had been; but never would be found a perfect dormant bud, except at the termination of a branch, after the branch was one year old. There seemed to be whole classes of trees with distinct peculiarities in this respect. Leguminosæ would preserve dormant buds for an indefinite number of years. In *Gymnocladus*, the Kentucky coffee tree, the axillary bud of the one year branch could be found twenty years afterwards just beneath the bark, in the position it first occupied, having in all that time grown just enough as the tree grew to keep just beneath the surface. The same is true of magnolias. In some, young branchlets came from the axillary buds the spring following their formation, and continued an existence as weak branchlets for a few years until starved out by the stronger ones, but when they reached a flowering condition the whole axillary bud died out with the effort of producing flowers. This was well illustrated by some maples. There was a third class which produced flowers and also an axillary bud, and these continued always through life twiggy branching trees, depending also on ultimate starvation of the branchlets to keep the supply of main branches within bounds. Birches are good examples of this class. The chestnut seems to be the only tree which takes the matter in hand in time, and keeps down a superabundance of branchlets by a disarticulation of the buds themselves, though in arbor vitæ, deciduous cypress, and some others, there is a disarticulation of superabundant branches after they are a year or so old, in this way keeping finally but a few main branches to preserve the form and permit of the functions of the head of the tree.

In the growing branch of the flowering chestnut tree the first four or five axillary buds, instead of a branch or futile buds for next spring, produce at once spikes of male flowers. Often the

whole mass of flowers which give so much charm to a chestnut tree fall off without any influence whatever on the fruit production of any trees in the vicinity, as the female flowers are not in bloom till these showy early ones have fallen, and depend on the second crop of male flowers for fertilization.

For what purpose is this immense mass of bloom with its resultant pollen created? Mr. Meehan believed that modern teleology based on the selfish idea that acts of each individual are solely for its own good, or the good of its immediate descendants, was wrong. The animal world, in the shape of insects perhaps, or in any other way, could be no more said to be created for the vegetable, as fertilizers of flowers, than were plants for them. It is a popular saying, that mouths were not created before something was prepared to put into them; and scientifically this might be reduced to the proposition, that plants may be made to behave and to produce, for ends having no relation whatever to their own individual wants, but that all things might be made to work together in harmony for some universal good.

Mr. Redfield asked whether it might not be that chestnut woods in more southern latitudes, and with female flowers more advanced, could receive the pollen from the precocious flowers of these northern trees; and, in view of the accidents liable to such a distant transmission by the winds, nature provided this immense superabundance to make the cross-fertilization more certain?

Mr. Meehan replied that he could not say; but if an answer to his questions were to be met by any of the prevailing theories on the necessities or utilities of cross-fertilization, he would like to ask what was the use of odor in the event of Mr. Redfield's question being answered affirmatively? The male flowers of the sweet chestnut were remarkably odoriferous. A fair sized bunch in a room would give fragrance to a whole house. Where would be the use of adding this powerful odor to flowers in mere arrangements for cross-fertilization by the aid of winds?

The following paper was ordered to be printed:—

ON THE GENERA OF FELIDÆ AND CANIDÆ.

BY E. D. COPE.

FELIDÆ.

The discovery of extinct species from time to time, renders it necessary to re-examine the definitions of the families and genera into which living forms naturally fall. We thus learn the characters of their primitive types, and the successive steps through which they passed in attaining their present characteristics. The *Felidæ* are known as that family of *Carnivora* in which the feet and teeth are most specialized for the functions of seizing and lacerating living prey. The number of living species enumerated by Dr. Gray is sixty-four, which he throws into a number of genera. The extinct species yet known are less numerous, but they present a greater variety of structure than the former. Two types or series may be recognized among the genera, namely those represented by the genera *Felis* and *Macharodus* respectively. All of the latter are extinct.

The greater number of the genera allied to *Macharodus* are distinguished by the great development of the superior canine teeth, whose crowns are generally compressed and trenchant. The corresponding part of the mandible is expanded downwards so as to furnish a protection to the slender crown from fracture by lateral blows when not in use, but in some of the genera, *e. g.* *Homotherium*, this feature is not developed. The only distinction

characters more fully than any other author. He points out the fact that in some of the species the orbits are closed behind, and in others open. He first examined into the manner of the contraction and closing of the pupil in the presence of light, and pointed out the fact that in the large cats it is always round and approximates a point in closing, while in the smaller forms the pupil closes as a vertical slit. He shows that the cats of the former group have the smaller orbits of the cranium, and the latter the larger. Dr. Gray, however, uses other characteristics in the discrimination of the genera, which are, in my estimation, quite inadmissible; as the relative length of the muzzle and of the premaxillary bones; also of the hair on different parts of the body and tail. Such features of proportion are essential as characters of species, but not of genera. In accordance with these views, I have united several of Dr. Gray's divisions into groups, which I call genera, and which repose on some definite structural characters. Thus I combine his *Uncia*, *Tigris*, *Leo* and *Leopardus* into a genus for which I employ his name *Uncia*, as the least objectionable,¹ after having confirmed by autopsy the circular character of the pupil. This I was enabled to do through the courtesy of my friend Arthur E. Brown, Superintendent of the Philadelphia Zoological Garden, who aided me in examining the eyes of these animals both by sunlight and the light of a bull's-eye lantern.² The detailed characters of the genera will now be given:—

1. The anterior and lateral faces of the mandible separated by an angle.

a. Inferior sectorial with a heel; no anterior lobe of superior sectorial; no posterior lobes of the premolars.

• An inferior tubercular molar.

Premolars $\frac{3}{1}$.

Dinictis.

Premolars $\frac{3}{2}$.

Nimræus.

I assume that this name is derived from *uncus*, a hook, which is appropriate to the weapons of these animals.

¹ I add the following notes on some other *Carnivora*, which do not come within the scope of this paper:—

Hyæna crocuta. Pupils a vertical slit.

Viverræ. Three species of *Ichneumon* and *vicerricula*, a horizontal oval

Nasua. A horizontal oval.

** No inferior tubercular molar.

Premolars $\frac{2}{3}$; incisors $\frac{3}{4}$.

Hoplophoneus.

Premolars $\frac{1}{2}$; incisors $\frac{1}{2}$.

Eusmilus.

aa. Inferior sectorial without heel; an anterior lobe of the superior sectorial, and posterior lobes of the premolars.

Premolars $\frac{2}{3}$, first inferior two rooted.

Machærodus.

Premolars $\frac{2}{3}$; first inferior one rooted.

Smilodon.

II. The anterior and lateral faces of the mandible continuous, convex. (No inferior tubercular molar.)

a. Inferior sectorial tooth with a heel.

Premolars $\frac{2}{3}$, no posterior lobes; second superior with internal heel (plantigrade).

Cryptoprocta.

Premolars $\frac{2}{3}$ with posterior lobes; no heel of second superior.

Pseudælurus.

aa. Inferior sectorial without heel; premolars with posterior lobes; superior sectorial with anterior lobe.

β. Superior sectorial with internal heel.

γ. Pupil round.

Premolars $\frac{2}{3}$.

Uncia.

Premolars $\frac{1}{2}$.

Neofelis.

γγ. Pupil vertical.

Orbit closed behind; premolars $\frac{2}{3}$.

Catolynx.

Orbit open; premolars $\frac{2}{3}$.

Felis.

Orbit open; premolars $\frac{1}{2}$.

Lynx.


ββ. Superior sectorial without internal heel.

Pupil round, premolars $\frac{2}{3}$; orbit open posteriorly.

Cynælurus.

The following catalogue includes the species of the *Felidae*, the names of the recent ones being derived from Gray's Catalogue.

Hoplophonus, Cope.*H. primævus*, Leidy. White River, Nebraska.*H. occidentalis*, Leidy. White River, Nebraska.**Eusmilus**, Gervais.*E. bidentatus*, Filhol. Phosphorites, France.**Machærodus**, Kaup. *Agnotherium*, Kaup. *Drepanodon*, Nesti.*M. palmidens*, Blv. Falunian Sansan.*M. ægyptius*, Kaup. Oeningian, Epplesheim.*M. antiquus*, Nesti. Pliocene, Italy, France.*M. falconeri*, Pomel. Upper Miocene, India.*M. cultridens*, Cuv. Pliocene, Europe.*M. latidens*, Ourn. Pliocene, England.*M. aphanista*, Kaup. Oeningian, Epplesheim.*M. maritimus*, Gerv. Pliocene, Montpellier.**Smilodon**, Lund.*S. neogæus*, Lund. Pliocene, Brazil.*S. necator*, Gervais, Buenos Ayres.**Cryptoprocta**, Bennett.*C. ferox*, Bennett. Madagascar.**Pseudelurus**, Gervais.*P. hyanoides*, Lartet. Falunian Sansan.*P. intrepidus*, Leidy. Loup River, Nebraska.*P. edwardsi*, Filhol. Phosphorites, France.*P. ? intermedius*, Filhol. Phosphorites, France.*P. arealensis*, Lydekker.**Catolynx**, Gray. *Viverriceps*, Gray.*C. marmoratus*, Martin. India, Borneo.*C. charltoni*, Gray. Nepal, Darjeeling (Charlton).*C. viverrina*, Bennett. East Indies.*C. planiceps*, Vig. and Horsf. Malacca, Sumatra, Borneo.*C. ellioti*, Gray. Madras.*C. rubiginosa*, I. Geoff. India, Madras.**Felis**, Linn. *Pardalina*, *Felis*, and *Chaus*, Gray.*F. pardalis*, L. America, tropical or subtropical.*F. grisea*, Gray. Guatemala.*F. melanura*, Ball. America.*F. picta*, Gray. Central America.*F. pardoides*, Gray.

- F. macroura*, Pr. Max. de Wied. Brazil.
F. mitis, F. Cuv. Mexico.? Paraguay.? .
F. tigrina, Schreb. South America.
F. geoffroyi, D'Orb. South America.
F. colocolla, Molina, South America, Chili (Molina), Surinam
(H. Smith).
F. jaguaroni, Lacép. South America.
F. eyra, Desm. Tropical America.
F. serval, Schreb. South and West Africa.
F. rutila, Waterhouse, Sierra Leone.
F. neglecta, Gray. Gambia.
F. servalina, Ogilby. Sierra Leone.
F. celidogaster, Temm. Guinea.
F. senegalensis, Lesson. Senegal.
F. minuta (pars.), Temm. Sumatra.
F. javanensis, Horsf. Java.
F. nepalensis, Vig. and Horsf. India (perhaps a hybrid or
domesticated).
F. chinensis, Gray. China.
F. pardinoides, Gray. India (Capt. Junes.)
F. pardochroa, Hodgson. Nepal (Hodgson). Tenasserim
(Packman).
F. tenasserimensis, Gray. India, Tenasserim (Packman).
F. jerdoni, Blyth. Indian Peninsula, Madras.
F. herscheli, Gray. India, "Zanzibar."?
F. wagati, Elliot. India.
F. calypta, Temm. Africa, North, South, Central, and East.
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Lynx, Raf. *Pajeros, Lynx et Caracal*, Gray.

L. pajeros, Desm. South America. The Pampas.

L. borealis, Gray. Northern Europe, Sweden.

L. canadensis, Geoffr. North America.

L. pardinus, Temm. Southern Europe, Turkey.

L. isabellinus, Blyth. Thibet.

L. rufus, Gldenst. North America.

L. maculatus, Vig. and Horsf. North America, Mexico, and California.

L. caracal, Schreb. Southern Asia and Africa, Persia and Arabia.

Neofelis, Gray.

N. macrocelis, Temm. Himalaya (Hodgson), Malacca.

N. brachyurus (Temm), Siam. Swinhoe, Formosa (Swinhoe).

Uncia, Gray, Cope emend. *Leo, Tigris et Leopardus*, Gray.

U. concolor, L. North and South America.

U. auratus, Temm. Himalaya, Sumatra, Borneo.

U. onca, L. South America, Mexico, Texas.

U. chinensis, Gray. Pekin, mountain forests of the west.

U. japonensis, Gray. Japan.

U. pardus, L. Southern Asia, North, South, and West Africa.

U. tigris, L. Asia.

U. leo, L. Africa, India.

U. irbis. Thibet.

Cynelurus, Wagler. *Cinopoda*, Gray.

C. jubatus, L. Africa, Asia, Persia, Cape of Good Hope.

? *C. ferax*, Leidy (*Aelurodon*). Loup River, Nebraska.

The successive order of the modifications of structure which define the above genera is not difficult to perceive, and it is interesting to discover that, as in other cases, it coincides with the succession in geologic time. The typical genera *Uncia*, *Felis*, etc., are characterized by great specialization, and it is they which now exist. The oldest found *Diictis*, *Nimravus*, etc., are the least specialized in most respects, and they disappeared before the close of Miocene time.

Since one of the special characters of the *Felidae* is the reduction in the number of the molar teeth by subtraction from both ends of the series, an increased number of these constitutes re-

semblance to other families. The genus *Dinictis*, above defined, has been shown by Leidy to possess two more inferior molars than *Felis*, or three more than *Neofelis* and *Lynx*, as in the *Mustelidae*. The extinct *Pseudaelurus* and the living *Cryptoprocta* have but one less molar than *Dinictis*, lacking the posterior tubercular. *Nimravus* has the same number of molars as *Pseudaelurus*, but lacks the first premolar instead of the last true molar. In *Hoplophoneus* we first find the number of molars as in the existing genera, viz., Pm. $\frac{3}{2}$ m. $\frac{1}{1}$. Other characters of this genus are, however, of a generalized kind.

I here recall the statement that the genera of *Felidae* fall into two series, which are distinguished by the forms of the anterior part of the mandibular rami, and generally by the large size of the canine teeth to which the former are adapted. This distinction appeared early in Miocene, or Oligocene time, in fact in the oldest of the cats of which we have any knowledge. The genera with large canines or Machærodontine line were then represented by *Dinictis*, and the Feline line by *Pseudaelurus*. It is interesting to observe that these genera differed from their latest prototypes in the same way, viz.: (1) in the presence of more numerous inferior molars; (2) in the presence of a beel of the inferior sectorial; (3) in the absence of an anterior cusp of the superior sectorial. In the case of *Dinictis* one other character of primitive carnivora may be noticed, viz.: the absence of the cutting lobes on the posterior edges of the superior and inferior premolars so distinct in the existing cats. The same feature characterize the superior premolars of *Pseudaelurus*, but the inferior premolar

the same conclusion in both, by the same stages. The primitive form of the Machærodont line represented by *Hoplophoneus* has its extreme in *Eusmilus*, where the second inferior premolar and an incisor tooth are wanting, giving a formula of I. 2, C. 1; Pm. 1; M. 1. In *Machærodus* we have the modern characters of the molars seen in *Felis*, viz., no heel of the inferior sectorial; the superior sectorial with an anterior lobe, and posterior lobes of the premolars. The extreme of this line is reached in *Smilodon*, where the second inferior premolar is one rooted or wanting. This genus then stands related to *Machærodus*, as *Eusmilus* to *Hoplophoneus*. In the Feline line proper, on reaching the existing genera, we have lost the heel of the inferior sectorial and gained the posterior lobes of the premolars and anterior lobe of the superior sectorial at once. A further modification of the dentition of the superior series of the recent forms, is seen in the loss of the first superior premolar in *Lynx* and *Neofelis*. Still another, which is one step beyond what is known in the Machærodont line, is the loss of the interior tubercle of the superior sectorial, which characterizes the genus *Cynalurus*. A superior sectorial tooth having the character of that of this genus was discovered by Dr. Hayden in the Loup River formation of Nebraska, and was referred to a species by Dr. Leidy under the name of *Aelurodon ferox*. It was much larger than the *C. jubatus*.

As already remarked, the genera of the Machærodont line are extinct, and this in spite of the fact that they presented the most perfect weapons of destruction in their canine teeth, from the earliest times. Their other modifications of structure advanced *pari passu* with those of the Feline series, and, among others, the feet presented in the latter forms at least (e. g., *Smilodon necator*, (Gow.), the most perfect prehensile power of the lions and tigers of to-day. As nothing but the characters of the canine teeth distinguished these from the typical felines, it is to these that we must look for the cause of their failure to continue. Prof. Flower's suggestion appears to be a good one, viz.: that the length of these teeth became an inconvenience and a hindrance to their possessors. I think there can be no doubt that the huge canines in the *Smilodons* must have prevented the biting off of flesh from large pieces, so as to greatly interfere with feeding, and to keep the animals in poor condition. The size of the canines is such as to prevent their use as cutting instruments, excepting

with the mouth closed, for the latter could not have been opened sufficiently to allow any object to enter it from the front. Even were it opened so far as to allow the mandible to pass behind the apices of the canines, there would appear to be some risk of the latter's becoming caught on the point of one or the other canine, and forced to remain open, causing early starvation. Such may have been the fate of the fine individual of the *S. neogaeus*, Lund, whose skull was found in Brazil by Lund, and which is familiar to us through the figures of Dr. Blainville, etc.

Description of New Species.

Dinictis cyclops.

The species of *Dinictis* differ in the proportions of their anterior molar and canine teeth as follows:—

First inferior molar one rooted; first superior molar two rooted; superior canine short, robust; large.

*D. intermedia.*¹

First inferior molar one rooted; superior canine compressed; two inferior incisors.

D. squalidens.

First inferior molar two rooted; first superior molar one rooted; canine long, compressed.

D. cyclops.

First molar of both jaws two rooted; canine long, compressed.

D. felina.

In the *D. cyclops* the first superior molar is rudimental, and will probably be found to be wanting in some specimens. The second premolar has a distinct anterior tubercle on the inner side,

heel of the sectorial is well developed. The tubercular is very small.

The form of the skull is short and wide; the zygomata are much expanded, and the profile is very convex. The muzzle is short, and the orbits are rather large. The interorbital region is wide and convex, and the postorbital processes are robust, acuminate, and directed downwards. The infra-orbital foramen is very large. The apices of the premaxillary bones are elongate, but do not reach the frontals. The nasals are rounded posteriorly. The sagittal crest is prominent, and theinion elevated. The posttympanic process is short, and the paroccipital is short and is directed backwards. The cranium is constricted behind the orbits. The mandibular ramus is low posteriorly, and the anterior inferior flange is well-developed, but not large.

<i>Measurements.</i>	<i>M.</i>
Length of skull on base . . . . .	.140
Width of skull, measured below . . . . .	.111
Length of palate . . . . .	.060
Width of palate between posterior angles of sectorials . . . . .	.062
Width of palate between canines . . . . .	.026
Length of skull to front of orbits (axial) . . . . .	.050
Vertical diameter of orbit . . . . .	.031
Interorbital width (least) . . . . .	.045
Elevation of inion from foramen . . . . .	.032
Length of inferior molar series . . . . .	.050
Length of inferior sectorial . . . . .	.018
Length of base of inferior first premolar . . . . .	.055
Depth of ramus at sectorial . . . . .	.016
Depth of ramus at first premolar . . . . .	.021
Depth of ramus at flange . . . . .	.026

From the Truckee beds of John Day River, Oregon.

CANIDÆ.

The range of variation presented by the species of *Canidae* includes several generic divisions, recent and extinct. These genera are, however, as closely intergraded as are those of the cats, and their definite characters are subject to occasional failure from ab-

normal variations. These are, however, not so frequent as to invalidate the classification to which they form the exceptions.

The *Canidæ* appeared in the Upper Eocene period, and the genus *Canis* was well represented by species in the lowest Miocene in Europe and the United States. The other genera are represented by fewer species, and many of them are extinct. The foxes (*Vulpes*) are the most numerous of them, and but few extinct species of them are known. America presents us with the greatest variety of genera, as *Enhydrocyon*, *Temnocyon*, and *Palæocyon* extinct, and *Icticyon*, extinct and recent. *Speothus*, extinct in America, still exists in Asia.

The most complete catalogue of the species *Canidæ* is that of Dr. Gray. In his work the author brings together observations of various naturalists, and adds a number of his own. He admits a large number of generic divisions, but many of these, like those of his *Felidæ*, are simply founded on specific characters. A few good genera, however, exist, and a synopsis of their characters is given below. The genus *Megalotis* is here excluded from the *Canidæ* on account of the unspecialized character of the superior sectorial tooth, as is done by Dr. Gray:—

I. True molars $\frac{3}{2}$.

Premolars $\frac{1}{1}$; inferior sectorial with internal tubercle.

Amphicyon.

II. True molars $\frac{3}{2}$.

Premolars $\frac{1}{1}$; inferior sectorial with internal tubercle.

Thous.

Pupil erect ; temporal fossa with simple superior border.

Vulpes.

Pupil erect ; temporal fossa bounded above by a rib-like crest.

Urocyon.

aa. Premolars 3.

Inferior sectorial with internal tubercle and cutting heel.

Enhydrocyon.

Inferior sectorial with internal tubercle, and wide tubercular heel.

Tomarctus.

IV. True molars 3.

a. Premolars 1.

Inferior sectorial with internal tubercle.

Speothus.

Inferior sectorial without internal tubercle (superior molar sometimes one).

Synagodus.

aa. Premolars 3.

Inferior sectorial without internal tubercle (incisors caducous).

Dysodus.

V. True molars 1

Premolars 1 ; inferior sectorial with internal tubercle.

Icticyon.

It is discoverable that the series represented by the above genera is a part of the greater line of the digitigrade *Carnivora*, embracing the greater part of it which is less specialized than, or inferior to, the part covered by the *Hyænidæ* and *Felidæ*. Without entering into the relations of the *Canidæ* with the civets and *Mustelidæ*, it may be remarked that the genera display a successive reduction in the number of premolars and molars from the more ancient to modern geologic times. It is interesting to note that the genera presenting the greatest reduction in all respects, *Synagodus* and *Dysodus*, are now only known in a domesticated condition. Another reduction is seen in the number of tubercles of the inferior sectorial.

Amphicyon, Lartet.

This genus is better represented in Europe than in North America, but two species being certainly known from the latter. No recent species.

Thous, Gray, *Dusicyon*, Smith (nomen nudum).

Existing species of South America only.

Palaeocyon, Lund.

Extinct species of South America only.

Lysaon, Brooks.

Existing species of Africa, only known as yet.

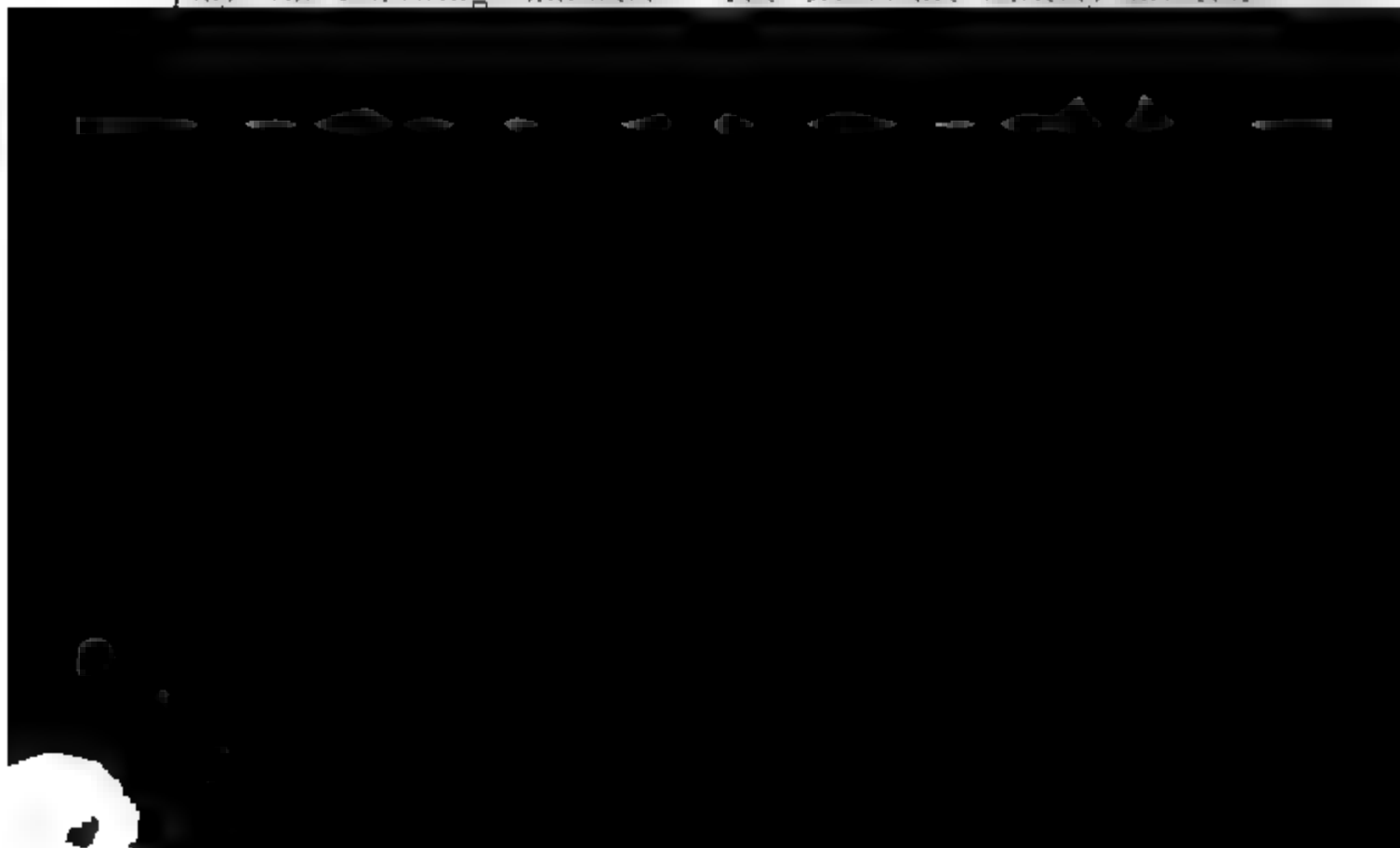
Temnocyon, Cope, Proceedings Amer. Philosophical Society, 1878, p. 48.

In this genus the heel of the inferior sectorial tooth rises into a single more or less median crest; in *Canis* the corresponding front is basin-shaped, with tubercles on each side. The superior molars of the typical species, *T. altigenis*, are unknown, but those of a new species, described below, do not differ from those of the genus *Canis*. The *Cynodictis crassirostris* of Filhol, from the French Phosphorites, approaches this genus.

Temnocyon coryphæus, sp. nov.

This is the most abundant dog of the Truckee beds of the John Day country. I have identified it heretofore as my *Canis hartshornianus*, but I find on examination of the inferior sectorial tooth that it is a species of *Temnocyon*. This genus was characterized by me on evidence furnished by a mandible of a species which I named *T. altigenis*,¹ which is of considerably larger size than the present one, but which agrees with it in the presence of a cutting edge instead of a basin on the heel of the inferior sectorial. The *C. hartshornianus*, known as yet from few fragments, is intermediate in dimensions between these two.

Several crania, and more or less of the skeleton of the *T. coryphæus*, are present in my collection. A nearly perfect skull displays the following characters: The orbits are entirely anterior



the brain case. The zygoma is rather slender, is elongate, and but little expanded. The otic bullæ are very large; the paroccipital processes are directed backwards, at an angle of 45° , and are rather elongate and acute; they cap the bullæ posteriorly. The lateral occipital crests bound a fossa of the occipital region near the condyles. The occipital surface is directed horizontally backwards above the foramen magnum. This part of it, and its superior portion, are divided by a median keel.

The basioccipital is keeled on the middle line below. The sphenoid is not keeled, and is concave, its borders descending on the inner side of the bullæ. The pterygoid fossa is rather narrow, and the hamular process is short. The posterior border of the palate does not extend anterior to the posterior edges of the last tubercular molar, and its middle portion projects backwards in a triangular process. The palatine fossa for the inferior sectorial is shallow. The superior surface of the postorbital region is roughened.

The *foramen infraorbitale exterius* is rather large, and issues above the anterior border of the sectorial tooth. The *f. incisiva* are short, not extending posterior to the middle of the canines. The *f. palatina* are opposite the posterior border of the sectorial. The *f. lachrymale* is altogether within the orbital border. The *f. opticum* is rather large. This species is peculiar in having the *f. f. sphenoorbitale*, *rotundum*, and *alisphenoidale anterius* united into one large external orifice. The alisphenoid canal is larger in *Canis intrans*, and its posterior foramen small. The *f. orale* is further removed from the *f. alisphenoidale* than in the coyote, and is exterior to and a little behind the *f. carotidæum*.

The nasal bones extend to above the middles of the orbits, and contract gradually to their apex. Their combined anterior border is a regular concave, and the lateral angles at this point are produced outwards and forwards. The posterior apex of the premaxillary bone is separated from the anterior apex of the frontal by a short space. The maxillo-malar suture is deeply notched in front below, and it extends upwards to above the infra-orbital foramen. A very narrow surface of the lachrymal is exposed on the external surface. The pterygoid bone is distinct, and is nearly equally bounded by the sphenoid and palatine on the outer side. The inferior suture of the orbito-sphenoid runs in a groove, which is deepest anteriorly.

The crowns of all the incisor teeth are narrow or compressed, and, though slightly worn, present no indication of notch. As usual, the external ones are much the largest in antero-posterior diameter. The canines have robust fangs and rapidly tapering crowns, which are but little compressed. The first superior premolar is one-rooted, and the crown is simple. The crown of the second is without posterior heel and tubercle, while the third possesses both. The sectorial is relatively short, less so than in *C. latrans*. The blades are low and obtuse as compared with recent species, and the notch separating them is quite open. The anterior external heel is small, and there is no anterior external tubercle. The first tubercular molar is large, and the crown is narrower than that of *C. latrans*. It has an obtuse external cingulum, two external conical cusps, a V-shaped median ridge, and a wide internal cingulum. This crown differs from the corresponding one of *C. latrans* in having conical instead of compressed external cusps, and a simple V-shaped crest within instead of two adjacent cusps. The second tubercular is smaller than in *C. latrans*, and its tubercles are less distinct. There are two outer tubercles, a V-shaped ridge, and an inner cingulum, all very obscure. The enamel of all these teeth is smooth.

Measurements of Cranium.

M.

Length along base of skull, including incisive border and occipital condyle . . . . .	.160
Length of skull to palatal notch . . . . .	.075
Length of skull to posterior border of pterygoid	

One of these exhibits the following characters: there is a well-developed marginal lobe of the posterior cutting edge of the third and fourth premolars as well as a low posterior heel, and a rudiment of an anterior one. The heel of the sectorial is shorter than the remaining part of the tooth, and rises to a cutting edge a little external to the middle line; there is a small tubercle at its interior base. The anterior blade-cusp of the sectorial is much lower than the median, which is conical; the two diverge, diminishing the shear-like character and action of the tooth. The internal cusp is well developed. The first tubercular is of moderate size, and is a longitudinal oval in outline. The crown supports two low tubercles anterior to the middle, of which the external is the larger. The last molar has a single compressed root, and the crown is a longitudinal oval in outline. Its position is on the ascending base of the coronoid ramus, so that the crown is slightly oblique. The masseteric fossa is profound and well defined; its anterior termination is below the middle of the second tubercular tooth. The horizontal ramus is not robust, but is compressed, and rather deep.

Measurements of Mandible.

<i>Measurements of Mandible.</i>		M.
Length along bases of posterior five molars . . . . .		.049
Length of base of fourth premolar . . . . .		.011
Elevation of crown . . . . .		.008
Length of base of sectorial . . . . .		.018
Elevation of crown of " . . . . .		.012
Length of base of first tubercular . . . . .		.0075
Width " " " " . . . . .		.0050
Length of base of second tubercular . . . . .		.0050

While the characters of this dog do not separate it widely from the genus *Canis*, many of them are quite different from those presented by the recent species of the genus with which I am acquainted. Thus the union of the foramina spheno-orbitale and rotunda, the anterior position of the orbits, and the postorbital constriction are not seen in the wolf, domestic dog, coyote, jackal, or the North American and European foxes. The size of the brain was evidently less than in those species, and the sectorial teeth quite inferior in the efficiency of their blades. These characters may be considered in connection with the low geological position of the beds in which the species occurs.

From the Truckee beds of the White River formation in Oregon.

Canis, Linn.

The names proposed by Smith, Gray, and others, and which must be regarded as synonyms of *Canis*, are *Lupus*, *Dieba*, *Sinemia*, *Chrysocyon*, and *Lycalopez*. Many of the species, referred to by European paleontologists under the name of *Cynodictis*, Pomel, appear to me to be undistinguishable from *Canis*. Through the great kindness of M. Filhol, I possess specimens of the jaws of several of these species. A mandible with nearly complete dentition of the *Cynodon velannum* of Aymard, agrees very nearly with the jaws of some of the smaller species from the American White River beds, which I have referred to *Canis*. *Helocyon*, Aym. may be distinct, but may not belong to the *Canidæ*.

The dentition of many of the recent species of *Canis* differs in very slight characters. The following may be detected in an examination of the superior molars of the three larger species most accessible in the United States.

Last superior tubercular short, wide; inner cingulum and crest nearly confounded.

Inner crest of tub. m. I. composed of two low tubercles.

C. familiaris.

Vars. molossus, terrarius, graius.

Last superior tubercular narrower, transverse; inner cingulum very distinct.

Inner crest of tub. M. I., a ridge higher anteriorly. *C. lupus*.

Inner crest of tub. M. I. with two sharp cusps. *C. latrans*.

Bernard, the bulldog, greyhound, and other races, nor in any of the feral or extinct species of the genus examined. It appears to be associated with an increased size of the brain, and to be an adaptation to the vermis of the cerebellum. The expansion of the brain is also indicated by the protuberance of the frontal region, and the wide separation of the temporal fossae by a smooth space on each side of the sagittal suture. This space does not exist in the greyhound, but a narrow one is found in the bulldog. These characters are important on various grounds, but are here mentioned in reference to the species of *Synagodus* and *Dysodus*, where they reappear. The absence of the second inferior tubercular molar is also not uncommon in the "black and tan" terrier.

I do not see the propriety of retaining the generic name *Nyctereutes*, Temm. for the *Canis procyonius* of Japan. The peculiarity it presents in the form of the first superior tubercular molar, the only one¹ on which the genus reposes, I would regard as specific only.

Valpes.

I would, with Gill, refer to this genus the species mentioned by Gray and others under the generic names *Pseudalopex*, *Fenestrona*, and *Lurocyon*. The form of the post frontal process certainly does not furnish generic characters.

Erocyon, Barl

The peculiar cranial ridges, in which this genus resembles one of the extinct genera of *Mustelida*, appears to me to be the character which warrants its separation from *Valpes*.

Enhydrocyon, Cope, Bulletin U. S. Geological Survey, Terr. v, 36, 1879

Two species from the White River beds of Oregon are known.

Tomarctus, Cope, Ann. Report U. S. Geol. Surv. Terr. 1873 (74), p. 319. Paleontological Bulletin, 1873, Aug. 20, 1873

One species known from the Loup Fork beds of Colorado. It is uncertain whether this genus has two or three premolars. Should it have three it must be compared with the *Brachycyon* of Fahlb. But the inferior sectorial tooth of that genus is as yet unknown.

Speothus, Lund, 1843. Cope, Hodgs.

One extinct species of this genus was found by Lund in caves in Brazil. Another species, *Speothus primæus*, is now living in

¹ According to the figures of Temminck and Re

the Himalaya region. Several other recent species have been named, but they are said by some authors to be varieties only of the *S. primævus*.

Synagodus, Cope, gen. nov.

The characters of this genus have been pointed out in the analytical key. They are evidently as important as those which define the divisions which are regarded as genera by naturalists. It is not unlikely that the typical species has been heretofore estimated as a variety of *Canis familiaris*, but it exhibits two trenchant generic dental characters not found in *Canis*, and three unique specific characters in the teeth, besides two characters of the cranium found in but one or two of the subspecies of *Canis familiaris*.

The generic characters alluded to are: (1) the absence of the second inferior tubercular molar, and (2) the absence of the internal tubercle of the inferior sectorial. The absence of the second inferior tubercular is evidently not one of those abnormal cases which occur in various species of *Canis* from time to time; for the first tubercular molar is smaller than in any known species of *Canis*, and has but one root, a character which some persons might regard as being the third of the generic category. The premolars are 4—4, and of the usual form; the first in both jaws is one-rooted.

It is uncertain whether any species of this genus exists in the wild state. Should such not be the case, we can only predicate the former existence of such an one entirely different from the

and in the other they are wanting. The III. and IV. incisors have marginal posterior lobes. The inferior second already stated, has no inner tubercle. Its heel is peculiar at elevation, and submedian position of one of its branches reaching *Temnocyon* in this respect. The other edge is distinct, thus forming an unsymmetrical basin. The first tubercular is small, one-rooted, and the crown is subround, with a single median tubercle. In the other usual species of *lupes*, and of many other genera of the family, this tooth is two-rooted, and supports at least two tubercles.

General form of the crania resembles those of some of the *Canis*. The brain-case is full and convex, the orbits are lateral, the muzzle is moderately elongate and narrowed. The osseous surfaces are generally smooth, and there is no indication of the deepening of the temporal fossa above. There is a deep sinus on the anterior border of the foramen magnum, a character above occurring in a subspecies included under *Canis familiaris*.

I have been unable to ascertain whether the species now designated as one of the forms which have been referred to *Canis* is under a subspecific name. One of the specimens was brought to the Academy many years ago by Dr. Paul Goddard, of the name of lap-dog. The form of the head shows that it is one of the forms of *Canis extrarius hispanicus* (of Fitzinger on Dogs), which are represented by the King Charles and other lap-dogs. As I can find nothing concerning it elsewhere I give it a provisional specific name.

The origin of the characters of this genus is doubtless to be sought in prehistoric time, if not to an early tertiary geologic age. Some of the species' characters are of later origin; such as the elevation of the superior border ridges of the temporal bone and the large sinus of the foramen magnum. These characters are in a lesser degree in a domesticated true *Canis*, as mentioned, are evidently an adaptation to an enlarged brain; to the increased cerebral hemispheres, the other to the increased vermis of the cerebellum. Whether these characters are the result of a prolonged domestication, and abnormal nutrition in human habitations, remains to be ascertained. I remark that two crania of dogs found mummied in Egypt by Mr.

Gliddon, and now in the Museum of the Academy, present all the normal details of structure of *Canis familiaris*.

The reduction in the number of teeth has been carried further, and is probably of more modern origin in the new genus to be described below.

Dysodus, gen. nov.

The characters of this genus, already indicated in the analytical table, are as follows: I. $\frac{3}{2}$; C. $\frac{1}{1}$; P. m. $\frac{2}{2}$; M. $\frac{2}{1}$; inferior sectorial without internal tubercle. The incisive formula might with propriety read $\frac{2}{0}$, since these teeth are shed at an early age; and for the same reason the tuberculars might be stated $\frac{1}{1}$, since the last one of the upper jaw is equally evanescent. I, however, give the genus the benefit of the possible future discovery of species in which the teeth in question may not be so early caducous, and rely on the restricted diagnosis. It is thus apparent that the genus *Dysodus* is distinguished from *Synagodus* by the absence of two premolars from each jaw. While the genera agree in other respects, their typical species are very different.

This genus probably diverged from that now represented by *Synagodus*, at a comparatively late period. Although it exhibits a degree of dental reduction greater than that form, I admit that the possibility of its having come off from *Canis* rather than from *Synagodus* is worthy of consideration. This is suggested by the fact that the remaining (first) tubercular molar of the inferior series is, in *D. pravus*, more like that of the species of *Canis* in all respects, among others, in having two roots.

the direct line of numerical succession of parts already represented by the genera of *Canidae*, and of all digitigrade *Carnivora*. This, as already stated, consists in the reduction in the number of the teeth and their tubercles, forming a series which, commencing with the generalized extinct type *Amphicyon*, approaches more and more nearly to the *Felidae*. In the inferior sectorial, the genus *Dysodus* approaches nearest of all *Canidae* to some of the earliest genera of cats, as *Hoplophonus* (although easily distinguishable), while in the reduction of its premolars it approaches the modern forms of that family. In the early shedding of the incisors it reaches a condition not found in any carnivora, but one which marks the extreme of development of the ungulate mammals in various lines; e. g., *Ruminantia*, *Omnivora*, and *Amblypoda*.

***Dysodus pravus*, sp. nov.**

This species, which is known as the Japanese sleeve dog, is represented in the Museum of the Academy of Natural Sciences by a complete skeleton, with the crania of two other individuals. These all belong to adult animals of a single litter, which were born in the United States. The parents of these dogs were procured in Japan by Dr. W. S. W. Ruschenberger, U. S. N., now President of the Academy. Other specimens have been brought to the United States by officers of the navy. Dr. J. E. Gray figures a skull of the same dog in the Proceedings of the Zoölogical Society of London for 1867.

The crania in the Academy's collection are almost exactly alike, and resemble the one figured by Dr. Gray so far as can be discovered. But Dr. Gray's specimen was probably young, as the incisor teeth and a premolar in each jaw have not yet been shed, and there are some cranial fontanelles still remaining.

The characters displayed by the skulls are as follows: The muzzle is excessively abbreviated, and the forehead very convex. The brain-case is almost globular, and the zygomata proportionably prominent. The superior marginal ridge of the temporal fossa is prominent, and those of opposite sides are well separated as far as the posterior parietal region. Here they approach each other abruptly, forming a wide sagittal crest. The muscular insertions and other osseous ridges of the supra, ex- and basi-occipital regions are strongly marked. The postorbital process is prominent and decurved. The vertical sinus of the superior border of the

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foramen magnum is deeply excavated. The external surface of the brain case and of the zygomata is minutely rugose.

There are no lobes of the posterior border of the anterior superior premolars, while they are present on the two inferior premolars. The superior sectorial is normal, while the first superior tubercular is like that of *Synagodus mansuetus*, without distinct median crest or tubercle. The heel of the inferior sectorial is also like that of the species just mentioned; one border is much more elevated than the other, and forms a cutting edge. The inferior tubercular is small, is longitudinally oval, and supports two low tubercles. This is one of the most important points of difference between this species and the *S. mansuetus*. In none of the specimens is there any trace of the second tubercular.

The skeleton is that of a dog of the size of a rather small black-and-tan terrier.

Dr. Ruschenberger states that the incisor teeth of the dogs were shed at an age of about six months. He also informs me that they did not breed after coming to this country. Dr. Gray states that these dogs are fed largely on vegetable food in Japan, and have an artificial existence in various respects. They are, according to Dr. Ruschenberger, uncommon and expensive in Japan.

I have been unable to discover that any name whether varietal or specific has been given to this dog.

Istioyon, Land.

One existing and one extinct species have been found in Brazil —
the latter on the coast of the state of Pernambuco, from the region of the

Char. specif. The snout is short and robust, and the profile from the parietal region is straight and descending. The premaxillary border projects but little beyond the line of the extremity of the nasal bones. The muzzle is slightly contracted in front of the orbit and above the fundus of the canine alveoli. The latter cause a swelling on the side. The infraorbital region is somewhat cracked, but appears to have been nearly flat medially; laterally it descends steeply to the supraorbital border. The orbit is not large, and the zygomatic fossa is short. The nasal bones are narrowed posteriorly, a little contracted medially, and expanded anteriorly, their lateral portions being produced along the pre-maxillaries. Their combined nasal border is concave, and is without the notches of some forms. The *foramen infraorbitale exterius* is of medium size, and issues above the interval between the sectorial tooth and the one in advance of it. The mandibular ramus is quite robust, and its inferior border is gently convex. The masseteric fossa is bounded by elevated borders, especially inferiorly, and the angular hook is prominent and robust. The condyle is situated on the horizontal line of the tubercular molar, or a little above the others, and has a wide transverse extent, chiefly inwards. The coronoid process is high and wide, and is turned backwards so as to vertically overhang the condyle. Its anterior border is wide below, and becomes horizontal above.

The teeth partake of the robust character of the skull, with the exception of the incisors. Of these the crowns of the external are long and narrow, and the median small in the premaxillaries, while those of the lower jaw are all small. The canines in both jaws are quite robust, and those of the lower jaw are rather abruptly recurved. The first premolar is small, and has a simple crown and single root. The crowns of the other premolars are wide at the base, and form each a simple cone, with a short posterior basal heel. The upper sectorial is relatively not long, but is robust, and with thick blades. The internal heel is well developed, as in *Canis*, while a cingulum represents an anterior lobe. The tubercular molar is narrower in fore and aft diameter than in *Temnocyon coryphaeus* or *Canis latrans*, although it presents the same details. These are a wide obtuse external cingulum; two external tubercles; a median obtuse tubercle, and a wide internal cingulum. The premolars of the lower jaw are similar to those of the maxillary bone. The inferior sectorial is quite robust, and

the internal cusp is well developed. The heel is shorter than the blades of the crown, and is wide and without tubercles in its somewhat worn condition. Its external border rises to an edge. The tubercular is wider than the corresponding tooth in the contemporary species of *Canidæ*, although not so wide as long. Its crown rises in two low tubercles which stand transversely near the middle.

<i>Measurements.</i>				<i>M.</i>
Length of skull to orbit (axial)	.	.	.	.049
Depth of skull to orbit (axial)	.	.	.	.042
Interorbital width	.	.	.	.040
Width of nares	.	.	.	.017
Length of superior molar series	.	.	.	.038
Length of bases of three premolars	.	.	.	.019
Length of base of sectorial	.	.	.	.013
Width of sectorial in front	.	.	.	.009
Width of first tubercular anteroposterior	.	.	.	.006
Width of first tubercular transverse	.	.	.	.014
Length of mandible to angle	.	.	.	.093
Elevation at coronoid	.	.	.	.051
Elevation at sectorial	.	.	.	.020
Length of inferior molar series	.	.	.	.045
Length of inferior sectorial	.	.	.	.014
Length of heel of inferior sectorial	.	.	.	.003
Length of inferior tubercular	.	.	.	.006
Width of inferior tubercular	.	.	.	.005

Van der Hoeven has given descriptions and figures of the

General Observations.

In both *Canidae* and *Felidae* the reduction of the dental series is connected with a contraction of the facial part of the skull, either posteriorly or anteriorly. *Euhyaenogon* is an example of anterior abbreviation, and *Ictiogon* of posterior contraction among *Canidae*, while *Smilodon* and *Lynx* exhibit the anterior reduction in *Felidae*. I have already pointed out that this reduction is accompanied by a corresponding increase in the size of the sectorial teeth. But the reduction in the number of teeth in geologic time has not been confined to the *Carnivora*, but belongs to the Ungulates and Primates as well. The small number of teeth is generally associated with high specialization among Mammalia generally. The genera *Synaptodus* and *Dysodus* are the most specialized of the *Canidae*.

I may here refer to the frequently observed reduced dentition of man. Darwin first pointed out the significance of the absence of the third molars from the standpoint of evolution, citing American cases; and I have observed the similar bearing of the absence of the external superior incisors.¹ These reductions are very frequent in the United States, and probably elsewhere among civilized nations, but statistics on this point are yet wanting. My friend Dr. C. N. Pierce, an experienced and scientific dentist of this city, informs me that he knows of twenty-eight families in which the external superior incisors are absent; to these, four families may be added, which have fallen under my own observation; that the absence of one or both pairs of the third molars is still more common, is confirmed by Dr. Pierce's experience.

It is evident that we have characters which, if stable, would indicate two or three genera of *Hominidae* additional to *Homo*. They are unstable at present; that is, they are not yet invariably found in any race or species of man, or, in other words, are not so associated with other physical characters as to form a correlated index of them. But experience in paleontology and zoology renders it almost certain that these dental characters will at some future time assume this degree of importance by becoming stable. This is already indicated by the fact of their being constant in families at the present time. As to what races will be thus distinguished

¹ Proceedings American Pⁿ

71, p. 234.

generically, it is not easy to indicate, but all those with prognathous crania may be safely excluded. It is improbable that Mongolian races will early participate in such a modification, as they have a tendency to prognathism, and a generally strong dental development.

Since the reduction in the number of teeth is intimately connected with orthognathism, it is easy to suppose that it is primarily due to the diminished space allowed by the contracted maxillary arcade. This contraction is doubtless due to a deficiency of building material, consequent on a transfer of force to some other part of the structure during the period of growth. This transfer may be to the superior parts of the cranium, which is extended to contain an enlarged brain. As the loss of a tooth from each side has so far been sufficient to accommodate the dentition to the space which it is to occupy, it is not likely that the absence of both I. 2, and M. III. will become established. The reduction in the inferior series is less, and I do not know of any examples of the absence of the external incisors of the lower jaw. The loss of the third inferior molars is, on the other hand, very common. It then may be reasonably maintained that two genera of *Hominidæ* will be at some future day added to *Homo*; that the latter will include the inferior races of men, and the future the superior; that, although in specific characters there may be a want of greater constancy in the species of the new genera as compared with each other than as compared with the primitive and true *Homo*, they will present cases of what is elsewhere known in zoölogy, that the same or nearly the same specific characters may be found in dif-

JULY 15.

The President, Dr. RUSCHENBERGER, in the chair.

11 persons present.

Death of J. B. McCreary, a member, was announced.

JULY 22.

Dr. JOSEPH LEIDY in the chair.

12 persons present.

Death of a Diamond.—Prof. LEIDY exhibited a black agate on, having mounted upon it, centrally in a raised gold setting, a diamond about 7 mm. broad. It had been submitted

by Mr. Ernst Kretzmar, jeweller, who informed him that a man who wore it recently was leaning with his head upon a window ledge in the sun, when the diamond exploded with sufficient force to drive a fragment into his forehead. On examining the fractured surface, following a cleavage plane, exhibits the remains of a thin cavity, such as is sometimes seen in crystals. The fracture also exposes a conspicuous parallel. Prof. Leidy thought that the explosion had been caused by sudden expansion of a volatile liquid contained in the cavity, which frequently occurs in cavities in many minerals.

Dr. Leidy thought that the liquid might be carbonic acid, and was impressed with the idea that diamonds originated from carbon in the liquid condition.

JULY 29.

The President, Dr. RUSCHENBERGER, in the chair.

14 persons present.

Deaths of Francis Garden Smyth, M.D., a member, and Edward Spach, a correspondent, were announced.

Death of Orgyia—Prof. LEIDY remarked that *Orgyia leucosticta* now seriously infested the shade trees of our city, the horse-chestnuts and silver-maples, had recently reached the moth stage. The trunks of the trees, and the iron railing of the square opposite to the Academy ex-

hibit a profusion of cocoons. In seeking for specimens of the male moth, he had collected only three, in a walk along one side of the square, from the railing, where hundreds of the wingless females were to be obtained, as they rested with their foamy white masses of eggs on their cocoons. From the fewness of the males he was led to suspect that the females might, perhaps, in many instances, deposit the eggs in an unfecundated condition. To ascertain if this were so, he collected several dozen cocoons with pupæ of females, distinguished by their comparatively robust character, and placed them in a covered box in his study in the third story of a back building, separated from the nearest place where there were other cocoons by the front building and the width of the street in front of his house. As the females came out of the cocoons, distended with eggs, these, with the exception of a few which appeared to be accidentally dropped in several individuals, were retained. After some days, as none of the females laid their eggs, the box was uncovered, and on the second morning subsequently, several individuals had deposited masses of eggs, though no males were present in the box. However, on examining the vicinity, four male moths were detected on the outside of the curtain of the window in which the box had been placed, from which it was supposed that the females had been visited by males attracted during the night from the neighborhood.

The case related reminded him that some years ago a collector of butterflies in the suburbs, informed him that he frequently obtained male specimens of the *Cecropia* and *Luna* moths by pinning females to the side of the window, when, in the morning after, he would almost certainly find males in conjunction with them. The means by which the males thus find their mates at night and in out-of-the-way places were not obvious, as the insects appear to be incapable of producing sounds or scents that are appreciable to our senses.

AUGUST 19.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-three persons present.

AUGUST 29.

The President, Dr. RUSCHENBERGER, in the chair.

Fourteen persons present.

SEPTEMBER 2.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty persons present.

SEPTEMBER 5.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-eight persons present.

A paper entitled "Description of a New Branchipod," by John A. Ryder, was presented for publication.

On Myrmecocystus Mexicanus, Wesm.—Rev. H. C. McCook exhibited several glass formicaries containing a large number of living specimens of the honey ant, *Myrmecocystus Mexicanus*, Wesm. These embraced three worker castes, major, minor, and dwarf, the honey-bearer, and the fertile queen. The artificial nests had been brought from the Garden of the Gods, Colorado, where the honey-ant had been discovered by Mr. McCook. They had previously been supposed to be confined to a more southern latitude. The nests are found on the tops or southern slopes of ridges. In exterior architecture they are small gravel-covered moundlets, truncated cones, pierced in the centre by a gate, or perpendicular opening from three to six inches deep. The interior architecture was illustrated by numerous specimens brought from excavated nests. It consists of a series of underground galleries and chambers, cut through the gravel and sandstone to the distance of nearly eight feet in length, two to four feet beneath the surface, and about ten to twelve inches in width at the widest part.

The honey-bearers were found harn

• roofs of

the honey chambers by their feet; their large globular abdomens looking like bunches of small Delaware grapes. About eight to ten chambers, containing each an average of about thirty honey-bearers, were found. The workers cared for the honey-bearers when the chambers were opened, and dragged them into the unopened parts.

The ants proved to be nocturnal in their habits, remaining within doors until after sunset, about 7.30 P. M., each evening, when the workers issued forth in column, and dispersed among the clumps of scrub oak, *Quercus undulata*. Here they sought the galls made by a species of *Cynips*, which grows abundantly on the bushes, and licked therefrom a sweet exudation which issued in small transparent beads from the surface. From 11.30 P. M. to about 3.30 A. M., when the first streakings of dawn began to appear, the workers returned home laden with the honey. This appears to be fed to the sedentary honey-bearers by disgorging it in the usual way, and remains within the globular abdomens as a store for future use. The economy of this habit appears to resemble that of the bee; the exception being that the bee's honey is stored within the inorganic substance of a waxen cell, while the ant's is lodged within the organic tissue of the living insect.

The above is a brief abstract of observations presented in detail, together with others not here referred to, which will appear in full in subsequent reports of the Academy's Proceedings.

Notices of some Animals on the Coast of New Jersey.—Prof. LEIDY exhibited a valve of the beach-clam, *Macra solidissima*, which he picked up among the numerous dead and bleaching shells of Brigantine Beach, N. J. It attracted his attention from its apparently having a fungus growing upon it. The fungus-like excrescence presented a remarkable resemblance to a *Polyporus* growing from the stem of a tree. It is an outgrowth from the lip

ced a conspicuous hemispherical tumor on one side of the
ace.

SEPTEMBER 16.

The president, Dr. RUSCHENBERGER, in the chair.

Twenty-two persons present.

The following was ordered to be printed:—

DESCRIPTION OF A NEW BRANCHIPOD.

BY JOHN A. RYDER.

Upon examining a pair of Branchipods which were kindly handed me by Mr. D. S. Holman, and which had been collected near Woodbury, N. J., I find them to be a form hitherto undescribed. I accordingly propose a name for the species.

Streptocephalus sealii, nov. sp.

In form and size this species resembles *S. torvicornis*, Waga, but the third joint of the second antenna differs from that species in the details of its structure, and the ovigerous sacs of the females are not blue as in Waga's animal. The inner branch of the terminal joint of the male claspers is the shortest instead of the longest, as in *S. torvicornis*; at the interior anterior margin of the short branch, there are two unequal lobes, extending forwards and lying flat against the laminar posterior border of the anterior branch; at the lower posterior angle of this lamina, or blade of the forward branch, there is a well-marked, somewhat falcate process, which fits between the lower lobular process of the posterior branch and its scythe-shaped lower extremity. The anterior branch then crosses the posterior at nearly right angles, and for about a third of its length maintains a pretty uniform thickness, and is straight, when it suddenly swells and bends forwards, and as suddenly contracts, and tapers for its remainder. Two



the accompanying cut of the head of the male. The front of the head is prolonged into a straight beak, which hangs down nearly vertically between the first joints of the claspers, and is flattened antero-posteriorly, and emarginate at its tip. The antenniform appendage is much longer than in *S. texanus*, Packard, whilst the terminal branches of the claspers are widely different from those of that species in their shape and relative proportions. The male organs are very feebly armed with a few short spines, and are nearly straight.

The cephalic horns of the female are twisted upon themselves, slightly bent and flattened at their extremities, which are fringed with short hairs. The large lateral, ovoid, pedunculate, apparently glandular organs behind the eyes, are the same in size and shape in both sexes. The ovigerous sacs are large, nearly half as long as the abdomen, conical in form, and contain a great number of ochraceous eggs, more numerous and much smaller than those of *Chirocephalus holmanii* from the same locality. The male is of a beautiful green, deeper about the head, as though saturated with acetate of copper; the female, on the other hand, is yellow with a tinge of green, verging to brownish in parts, and is very nearly of the same size as the male, if not a little larger. This similarity in the size of the sexes, with a tendency in the females to be largest, is observed only in *S. torricornis*, as far as I am aware. The two rather long, plumose, tapering branches of the tail are red in both sexes, but of a much brighter red in the female; more slender in the male. Length 27 mm.

I name the species for Mr. W. P. Seal, who collected the first typical specimens; the same gentleman has since furnished me with an additional supply of examples.

The known species of this genus are accordingly as follows:—

Streptocephalus torricornis, Waga, ♂ 1 inch, ♀ about 14 lin., Warsaw, Poland.

S. cafer, Lovén, 15 mm. long, Cape of Good Hope.

S. similis, Baird, ♂ 8 lin., ♀ 6 lin. long, St. Domingo.

S. texanus, Packard, ♂ .65 in., ♀ .55 in. long, Texas.

S. iratzoni, Packard, ♂ 16 mm., ♀ 12–18 mm., Ellis, Kansas.

S. sealii, Ryder, 27 mm. long, New Jersey.

All of the species are found in fresh water.

The distribution of the foregoing genus, and the resemblance exist
between the Polish and New

Jersey species is very remarkable. Why such a resemblance should exist between two fresh-water crustaceans separated from each other by a salt ocean 3000 miles wide, and nearly a thousand miles of land besides, is a problem yet to be solved by chorologists and biologists. Indeed, the distribution of both branchipods and phyllopods in general, is not a little singular, and all those who have the opportunity of acquiring any data in regard to the subject should be careful to put them on record.

SEPT. 23.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-five persons present.

SEPT. 30.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-two persons present.

The death of Edward Peace, M.D., a member, was announced.

On Cristatella Idae.—Prof. LEIDY remarked that a few days ago, while rambling in the Park with his little daughter, she had called his attention to what she supposed to be numerous caterpillars at the bottom of a brook. On examination they proved to be an extraordinary accumulation of *Cristatella Idae*. This species of polyzoon, or fresh-water ciliated polyp, he had discovered at Newport, R. I., upwards of twenty years ago, and described in the Proceedings of this Academy (1858-59). He had repeatedly sought for it in the vicinity of Philadelphia, but had never found it until now.

The development of the *Cristatella* in the locality indicated is most remarkable and wonderful for its extent. Thousands of vermicular groups spread over the bottom of the brook for about twenty feet of length and a yard diminishing to a foot in breadth. They invest all the submerged stones and plants, and are so closely crowded as to intertwine with one another, leaving only narrow intervals, without room for movement except by mutual displacement. The groups are all attached to a common basal membrane, from which, however, they are capable of separating themselves. A large patch of the membrane covered with groups of the *Cristatella* was raised and placed in a dish of water, and after a couple of days most of the groups glided away from the membrane to the bottom and sides of the dish. The basal membrane is amber colored, homogeneous, and obscurely granular. A patch of it, four inches long by two and a half inches wide, closely covered with groups of the polyp, preserved in alcohol, was presented as a specimen for the museum.

It would appear that in the development and growth of the *Cristatella* groups, they from time to time break up into smaller groups, and retain their connection only through the basal membrane, which seems to be of an exoremanthous character.

The basal membrane of the *Cri*
from the circumstance that in the
it harbored multitudes of *Di*

→ interesting
of polyps

At this season the *Cristatella* groups are full of statoblasts or winter eggs, in all stages of development. The mature statoblasts, including the annulus, but excluding the marginal anchor spines, measure from 1.15 mm. to 1.225 mm. in breadth. Of fifteen specimens, seven measured 1.2 mm. in breadth. The number of anchor spines usually ranges from 60 to 70; but in a few specimens as low as 53 and as high as 74 were counted. Both in size and the number of spines they considerably exceed those of *Cristatella mucedo* and *C. ophidoidea*.

The individual polyps of *Cristatella Idae* when fully extended are about 3 mm. in length, and their arms support about 80 tentacles. The stomach is chocolate brown; sometimes lighter yellowish or greenish-brown.

The same locality was further remarkable for its profusion of other animals, especially for the abundance of flesh-colored Hydras, and the groups of Vorticellas. Tufts of *Anacharis* were white from the latter.

Lieut. C. A. H. McAuley, U.S. A., was elected a correspondent.

OCTOBER 7.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty persons present.

On Amœba Blatta.—Prof. LEIDY remarked that while perusing the communication of Prof. Bütschli on "Flagellata and other related Organisms" (Beiträge zur Kenntniss der Flagellaten und einiger verwandten Organismen), in the Zeitschrift für wissenschaftliche Zoologie, 1878, 205, his attention was especially attracted by the description of a parasitic amœboid living in the intestines of the cockroach, *Blatta orientalis*. It seemed to him

entiation of endosarc and ectosarc; and from the latter in the possession of a well-defined nucleus. He proposed for it the following name with distinctive characters:—

ESDAMOBA.

General character and habit of *Amorba*: composed of colorless, homogeneous, granular protoplasm, in the ordinary normal active condition without distinction of ectosarc and endosarc; with a distinct nucleated nucleus, but ordinarily with neither contractile vesicle nor vacuoles.

ESDAMOBA BLATTÆ.

Ess. art. Proteus. Seibold: Beitr. z. Naturges. d. wirb. Thiere, 1839, *vide* Stein.

Amorba form. Stein: Organismus d. Infusionstheire, 1867, II, 345.

Amorba Blattæ. Butschli: Zeits. f. wis. Zoologie, 1878, xxx, 273, Taf. xvi., Fig. 26.

Initial form globular passing into spheroidal, oval, or variously lobate forms, mostly clavate and moving with the broader pole in advance. Protoplasm finely granular, and when in motion more or less distinctly striate. Nucleus spherical, granular, with a large nucleolus. Distinct food particles commonly few or none. Size of globular forms 0.054 mm. to 0.075 mm. in diameter; elongated forms 0.075 mm. by 0.06 mm. to 0.15 mm. by 0.09 mm. Parasitic in the large intestine of *Blatta orientalis*.

The *E. amorba blattæ* affords a good example of a primitive, active nucleated organic corpuscle, or a so-called organic cell without a cell wall. In the encysted condition it would be a complete nucleated organic cell. *Esdamoba* may be recommended as a convenient illustration of a primitive form of the organic cell on account of its comparatively ready access.

OCTOBER 14.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-two persons present.

On the Supposed Sensitive Character of the Glands of the Asclepiadaceæ.—Mr. E. PORRS, referring to a communication made a year ago to the Academy and published in its Proceedings for 1878, p. 283, with regard to the supposed discovery of a sensitive contractile power analogous to that of *Dionea*, in the stigmatic glands of the Asclepiadaceæ, said that during the past summer he had given many hours to a careful examination of the subject, resulting in an entire failure to confirm his former position. This examination had embraced at least five species of the typical genus—*Asclepias*, and single species of each of the allied genera,—*Araujia*, *Physianthus*, *Bona. Gonolobus*, and *Stapelia*.

The phenomena which, last year, were regarded as showing great probability, if not convincing proof, of the contractile power referred to, were:—the grasping of a slender hair by said glands with sufficient force to allow of the withdrawal of the pollen-masses; and a coincident change in the appearance of the jaws or lips of the same glands. The facts are undoubtedly as stated; but the circumstances attending the change had been imperfectly noted or their significance misinterpreted. The lips of the glands in their primary, undisturbed position, which had been thought to be separated by a sensible distance, allowing of the insertion of the foot or proboscis of an insect were now seen to be thickened and chamfered off along the upper edge, leaving a wedge-shaped groove, but still touching one another at the lower surface. No accidental or intended intrusion would therefore be successful in reaching the inner surface of the cylindrical gland; and by very many experiments it was amply proven that no amount of touching or pressure upon the *edges* of this groove was followed by any change of position.

He then explained how the removal of these glands and their associated pollinia was effected by insect agency, calling attention to the narrow passage left between the rigid proximate edges of the adjacent anthers; showing that it was widest at their lower extremity, and quickly narrowing, led up into, and was continuous or coincident with the before-named groove through the gland; so that the foot of fly or bee inserted below while the insect was crawling over the flower, was almost necessarily drawn along it until it reached and entered the gland. The very delicate attachment of the latter to the stigma was then easily ruptured, and the insect escaped, carrying glands and pollinia with it. Experiment showed that it was only when the glands were so far removed from their proper position that the caudicles or arms connecting them with the pollen masses were relieved from the restraint in which

In this particular species, alone, of those examined, the release of the insect was not effected when it had successfully drawn foot or tongue along the whole length of this anther trap, as the gland which then receives it is firmly attached to the stigma by a broad ligament at its upper end; and all, excepting possibly the most powerful insects, are still held, while from other species of the family they fly off bearing the pollen masses with them. These in turn are caught in similar channels of other flowers, and lodged against the under surface of the stigma, when their pollen tubes are protruded and fertilization effected.

Thus, if not necessarily *cross* fertilization is, at least, fertilization by pollen from the same or other flowers placed by an extraneous force against the stigmatic surfaces; and that the singular arrangement of parts just mentioned, apparently so wonderfully calculated to facilitate it, *is* made use of, is very evident. In the course of his observations upon a cultivated plant of *Asclepias corossarium* during the season of insect visitation, it was rare to find a mature flower which had not lost some of its glands and pollen masses, and very frequently all were missing. In many of these, the pollenia from other flowers were to be found in the situation before stated; and it was a very noticeable fact that from 50 to 80 per cent. of the flowers in these groups were fertilized, while those from which insects were excluded failed to produce a single fertile follicle. A bee captured upon this plant carried upon its legs and tongue thirty of the glands, representing sixty pollen masses. By far the larger number of the latter had been torn away from the glands since their removal, and possibly were the agents in making fertile nearly the same number of flowers.

A very singular fact on the opposite side of the account was mentioned by Mr. Meehan in the Botanical Section: that *Dracopis* *virginica* is rarely fruited when exposed to insects in the open air, but in green-houses produced pods freely.

On Amber containing Fossil Insects.—Mr. E. GORDSMAN called attention to a specimen of amber collected by Mr. Wm. L. Mactier at Nantucket Island, Mass., in which were several well preserved fossil ants, a fly, and probably small species of coleoptera. The specimen also contains a dicotyledonous leaf, of a cinnamon brown color, with the edges free, and the impression of another. This was the first specimen of American amber examined by him in which a trace of imbedded insects could be observed, although this may have been owing to the fact that the others were cretaceous, and therefore, on account of their age, opaque.

The amber from Nantucket Island is probably tertiary, and is of a fine pale claret color without being at all variegated. The specimen examined was an irregular mass of about eleven centimetres in length, somewhat pointed at one end and thicker and rounder at the other, with longitudinal furrows. It is a little heavier than water. The lustre is resinous, but if

it is glassy. The form of the fracture is conchoidal and perfectly smooth. Hardness between two and three. The specimen resembles in its external aspect fossil copal so much that it may be easily mistaken for that material. The fresh vitreous lustre of the amber, however, remains after repeated rubbing and exposure, while copal becomes dull under such treatment. The amber may be worked with a file or an edge tool into even surfaces; under like treatment copal crumbles, and gives an uneven glistening plane. When the finger is rubbed to and fro on the amber it will not powder or become mealy like copal. When a portion of the specimen was gently heated in a glass tube closed on one end a dense gas was obtained having the odor of burning fat. After cooling minute radiating groups of crystals were noticed; fossil copal gives no such indications. The amber burns with a yellow smoking flame, emitting an odor not so disagreeable as that given off during distillation, and leaves some unconsumed carbon. The powder is white, and, if brought in contact with oil of vitriol, it will readily dissolve, forming a ruby red solution, which, when poured into water, gives a nearly colorless precipitate partially in a crystalline state. It is decomposed by nitric acid, forming at first a soft yellow compound which afterwards dissolves. If the excess of the nitric acid be evaporated and water added, thin plates of a golden-yellow color form. These plates appear to be succinic acid; they easily dissolve in caustic ammonia, and the solution affords, with a solution of sesquichloride of iron, the well-known cinnamon-brown precipitate of succinate of iron. Both solutions were perfectly neutral. From the solution of the succinate ammonia the succinic acid can be separated on the addition of nitric acid. This process for observing succinic acid in amber is especially applicable when but a small quantity of the acid is present, in which case the process by sublimation fails or becomes uncertain. Chloroform is a good solvent for amber, but alcohol,

been induced to make it a visit. Though he had seen collections of casts of fossils and skeletons in the museums of colleges and other institutions, from Prof. Ward's establishment, he had not been prepared to find it so extensively representing all departments of natural history as it proved to be, and even in Europe he had seen no dealer's stock that was equal to it. For the variety of its objects, and the excellence of preservation and preparation of the specimens, he recommended it to the Academy and to others as a source from whence to supply the wants and deficiencies of their cabinets. The collection of skeletons is large, and is admirable for the cleanness, whiteness, and perfect mounting of the specimens. A few thousand dollars expended in this department would be of much importance to the museum of the Academy. A collection of glass models of invertebrate animals, made by Leopold Blaschka, of Dresden, had especially attracted his attention. The models are remarkable for their accuracy and beauty, and they supply a means of illustration which has long been felt. They represent soft and delicate forms which cannot be satisfactorily preserved, and others too minute to be examined with the naked eye. Moreover their price is so moderate, that it is to be hoped that the Academy may make early provision to obtain a series. Prof. L. exhibited specimens, such as the Red Coral, *Corallium rubrum*, of the natural size and magnified; the hydroid polyp, *Hydractinia echinata*, which lives on the shell of the Hermit Crab, etc. Prof. L. added that at the present time when society was awakened to the importance of the study of natural history, Prof. Ward was worthy of the highest commendation for the ability and energy he had displayed in accumulating so ample a means for its illustration.

OCTOBER 28.

The President, Dr. RUSCHENBERGER, in the chair.

Forty-nine persons present.

The following papers were presented for publication:—

"Revision of the Palæocrinoidea, Part I., the Families Ichthyocrinoideæ and Cyathocrinoideæ," by Charles Wachsmuth and Frank Springer.

"A Comparison of the Eocene Mollusca of the Southeastern United States and Western Europe in relation to the determination of identical forms," by Angelo Heilprin.

The death of William H. Gumbes, a member, was announced.

Variations in Thupa and Retinospora.—Mr. THOMAS MEEHAN referred to his observations reported to the Academy many years

ago, showing that the plant known in gardens as *Thuja ericoides* was but a form of arbor vitæ that had carried its juvenescent condition through life, instead of changing its character for the "adult" condition after its first three months of existence, as arbor vitæ generally do. Out of a large number of trees of this form that had been growing on his grounds for fifteen years, one had assumed the normal adult condition. Since he had first recorded his observations, most of the leading botanists had come to regard these plants as he did, and there seemed no need of further evidence; but this changed plant had now produced fruit for the first time, specimens of which he exhibited. It was exactly *Thuja occidentalis*. These juvenescent forms after fifteen years' growth had shown only this single disposition to assume the final or adult condition or to flower. He also exhibited a similar juvenescent form known as *Retinospora squarrosa*, one plant of which out of some hundreds had developed to *Retinospora obtusa*. In the case of the arbor vitæ the change from the juvenescent to the adult form was gradual; in *Retinospora* it was by a single leap. Each condition had its separate color, and separate chemical principles, the latter point having been called to Meehan's observation by Dr. Sterry Hunt; but this was characteristic of all such morphological changes. There was a difference in the rind of orange and in its pulp,—in the flesh of the peach and in its kernel, though all were morphologically the same. It was, however, worth remembering that with morphological changes there was often change in cell structure, as well as in sensible properties. Mr. Meehan further called attention to the almost identical characters of the two juvenescent forms exhibited—while in the adult they were so widely divided—for there were in all Coniferae probably no two genera better marked in the characters derived from their fructification than *Retinospora* and *Thuja*.

Russell S. Hill was elected a member.

ON SOME NEW EOCENE FOSSILS FROM THE CLAIBORNE MARINE
FORMATION OF ALABAMA.

BY ANGELO HEILPRIN.

The following species of fossils (with the exception of *Rostellaria Whitfieldi*) were picked out from an accumulated mass of Claiborne sand and shell, deposited in the American Museum of Natural History, New York City, and being of more than ordinary interest, as in part pertaining to genera hitherto not recognized as belonging to the formation, I have deemed them worthy of description.

TEINOSTOMA, H. & A. Adams.

Teinostoma retula, nob. Pl. xiii., fig. 1.

Shell orbicular, depressed; polished; whorls three, body-whorl with an impressed line immediately below the suture; umbilicus small, surrounded by a broad callous area; aperture nearly circular; inner lip expanded into a callus near the umbilical region.

Diameter .2 inch.

Claiborne, Alabama.

This is the first species of *Teinostoma* described as such existing in the Eocene formations of the United States. Mr. Lea's *Rotella nana* (*Umbonium*, Conrad), also from Claiborne, which I have not had an opportunity to examine, may prove to be a *Teinostoma*.

DELPHINULA, Roissy.

Delphinula solaroides, nob. P. xiii., fig. 2.

Shell turbinate, depressed, broadly umbilicate; whorls four, channeled below the suture, and ornamented with obtuse ribs radiating from about the centre of the upper surface; umbilicus with a central unrolling prominent crenulated line, and intermediate finer lines; margin crenulated; peristome continuous, trumpet shaped. Nacreous.

Diameter $\frac{1}{2}$ inch.

Claiborne, Ala.

This species could readily be mistaken for a *Solarium*, from all species of which, however, it is distinguished by its pe
isidaceous

SOLARIUM, Lamarck.

Solarium striate-granulatum, nob. Pl. xiii., fig. 3.

Shell conical, depressed; whorls five, slightly convex, and ornamented with four principal revolving lines of granules; margin acute, crenulated, and carinated only on the inferior surface; base with three prominent crenulated lines surrounding the umbilicus, and with about three or four almost simple lines.

Diameter $\frac{3}{4}$ inch.

Claiborne, Ala.

NATICA, (Adams.) Lam.

Natica bi-sulcata, nob. Pl. xiii., fig. 4.

Shell subglobose; spire but slightly elevated; whorls four, smooth, the body-whorl with radiating sulci on the summit; mouth semi-lunate, about $\frac{2}{3}$ the length of shell; columella slightly thickened, the callus reflected above the middle; umbilicus broad, doubly grooved, the grooves transversely striated.

Length .3 inch.

Claiborne, Ala.

This species differs mainly from the *N. magno-umbilicata* of Lea in having the umbilicus doubly grooved.

ODOSTOMIA, Fleming.

Odostomia laevigata, nob. Pl. xiii., fig. 5.

Only a fragment of this species has come to my observation, but its characters are sufficiently defined to distinguish it from all



the remaining whorls also with two smooth bands; mouth narrow, about $\frac{2}{3}$ the length of shell.

Length .4 inch.

Claiborne, Ala.

This species differs from the *Actæon* (*Tornatella*) *lineatus* of Lea (*A. idoneus*? Conrad) in having two smooth bands on the upper portion of the body-whorl instead of one. Mr. Lea mentions having in his cabinet a species from the Paris basin also with two bands, but I fail to discover the same described in the work of M. Deshayes.

PISANIA, Bivon.

Pisania bucciniformis, nob. Pl. xiii., fig. 7.

A fragment only of this, the first described species of true *Pisania* existing in the Eocene formations of the United States has come to my notice. The body-whorl is about $\frac{2}{3}$ inch in length, striated on the inferior portion, and with a slightly impressed line beneath the suture; mouth about $\frac{2}{3}$ length of body-whorl; canal almost obsolete; columella arcuate, wrinkled at base; outer lip striated within by about seven elevated ridges.

Length ?.

Claiborne, Ala.

The *Pisania Claibornensis* of Whitfield (Am. Journ. Conchol., vol. i., p. 259) appears from the description and figure to be more nearly related to *Triton*.

CONUS, L.

Conus pulcherrimus, nob. Pl. xiii., fig. 8.

Shell conical; spire elevated; whorls about seven, slightly concave above, granularly crenulated on the angle, and transversely striated; a prominent simple line below the angle, and one of granulations beneath the suture. Aperture?

Length about $\frac{1}{2}$ inch.

Claiborne, Ala.

PLEUROTOMA, Lam.

Pleurotoma insignifica, nob. Pl. xiii., fig. 9.

Shell fusiform, with prominent revolving lines below the middle of the whorl; spire elevated; whorls about five, angular; canal short, obliquely curved; mouth contracted.

Length $\frac{1}{4}$ inch.

Claiborne, Ala.

The description and figure of *Fusus nanus* as given by Lea in his "Contributions," agree in all essential respects with the above. No mention is made of the sinuated lines of growth peculiar to the *Pleurotomæ*, which in our specimens are very distinct. Although I have not had an opportunity to examine Mr. Lea's specimens, it appears to me, nevertheless, highly probable that his *Fusus* will prove to be a *Pleurotoma*.

Pleurotoma denticula, Rastrot. Pl. xiii., fig. 10.

This species, which is one of the most widely diffused of all fossil *Pleurotomæ*, has to my knowledge not been hitherto described as occurring in any American formation. The *P. nodocarinata*, Gabb (unfortunately very poorly figured), in the collections of the Academy belongs to this species. Specimens are to be found also in the Claiborne accumulation of the American Museum of Natural History, New York.

MELANIA, Lam.

Melania Claibornensis, nob. Pl. xiii., fig. 11.

Shell elongated, turreted; whorls eight, of which the first three are smooth, and the rest furnished with longitudinal folds, those on the body-whorl terminating at about the middle; folds cut by numerous deeply impressed revolving lines, giving a somewhat imbricated appearance; mouth elongated, oval contracted above, and expanding at the base; columella broad, flattened.

Length .3 inch.

Claiborne, Ala.

This species, to which I have provisionally applied the specific

numerous, less prominent on the middle of the whorls; aperture ovate, produced into a short canal.

Length $\frac{1}{4}$ inch.

Claiborne, Ala.

This species closely resembles, but is less slender, than the *Rissoa inchoata*. Desh., of the Paris basin.

MESOSTOMA, Deshayes.

Mesostoma rugosa, nob. Pl. xiii., fig. 13.

Shell conico-turbinate; whorls about seven, scalariform, the first three smooth, the rest ornamented with oblique longitudinal plications, which are crossed by five prominent and a number of lesser revolving ridges, giving the whole a cancellate appearance; the folds on the body-whorl cease abruptly below the middle; aperture sub-circular, dilated, and produced into a short oblique canal; outer lip somewhat crenulated by the terminations of the revolving ridges.

Length .4 inches.

Claiborne, Ala.

Four species in all are catalogued as belonging to this genus, all from the Eocene of France. The above species differs from the *M. grata*, Desh., of the Paris basin only in the number of its revolving ridges. The *Cerithioderma prima* of Conrad, from the American Eocene, is a *Mesostoma*.

Note.—There is some difficulty in determining the priority in the institution of the genera *Mesostoma* and *Cerithioderma*. Tate (Appendix to Woodward's "Manual," 1868) quotes the genus *Mesostoma* from the year 1864, whereas that portion of Deshayes's work, wherein the genus is described, bears the date of 1858. This is the second year of the publication of the entire work, and as the first volume (Lamellibranchiata) was not completely issued until 1860, it is highly probable that the genus was not characterized prior to that year. Conrad published his genus *Cerithioderma* in March, 1860 (J. A. N. S., vol. iv., 2d series), as founded upon a single species *C. prima*, but as his characterization is vague and very meagre, it appears more natural to accept the genus of Deshayes, which has already been accepted by most conchologists.

ROSTELLARIA, Lam.

***Rostellaria Whitfieldi*, nob. Pl. xiii., fig. 14.**

Shell fusiform; spire tapering, consisting of about nine flattened volutions; body-whorl sub-angulate beneath; columella flexuous, with traces of an obtuse fold; outer lip with a swollen prominence in the apertural region; wing?

Length 3-4 inches.

Claiborne, Ala.

Named in honor of R. P. Whitfield, Esq., the distinguished American paleontologist and colaborer with Prof. James Hall in the great work on the paleontology of the State of New York.

Two specimens of this species, both unfortunately bereft of their wings, are in possession of the American Museum of Natural History of New York. Their characters are so decidedly at variance with those of any other American Eocene *Rostellaria*, that we feel no hesitation in applying to them a specific name, although the broken nature of our specimens necessitates an incomplete description. Allied species occur in the London clay and in the Paris basin.

A COMPARISON OF THE EOCENE MOLLUSCA OF THE SOUTHEASTERN UNITED STATES AND WESTERN EUROPE IN RELATION TO THE DETERMINATION OF IDENTICAL FORMS.

BY ANGELO HEILPRIN.

The study of the fauna, whether extinct or living, of any country resolves itself into two distinct methods of investigation, the general and the comparative. In the general method we look upon an assemblage or community of animal forms as constituting an integral part of the country it characterizes, and we then consider it only in relation to that country and to itself the animal forms *inter se*). In the second or comparative method we no longer regard this community as constituting a whole or unit, but merely as a part of a more extensive community, and we now view it in the relation of a part to a whole. This comparative system of investigation, which, it will be manifest, involves a thorough general acquaintance with all or most extraneous faunae as well as the one under special consideration, is one of great difficulty, and one that requires more than an ordinary amount of acumen in its pursuit, for in the broad facts of geographical distribution are connected some of the profoundest biological and physical problems. The study of comparative or geographical zoology constitutes one of the essential factors of biological science, for without a true understanding of the general affinities of scattered groups of animals, our conception of the organic universe would be one of disjointed parts instead of a continuous whole. We know, in fact, little of a whole unless we comprehend its relation to its component parts, and *per contra*, we know little of a part unless we understand the relation it bears to the whole.

The subject of geographical distribution in its bearings on geology, whether considered in its broader sense as pertaining to groups, or in the more limited sense as pertaining to the individuals composing those groups, cannot be over-estimated. It is by the recurrence over broad or scattered areas of certain related animal types, and sometimes even over the most remote areas of identical specific forms, that the paleontologist is enabled to arrange and classify his strata. One single well-determined fact, in the absence of further data, frequently d

and sometimes exactly, certain geological horizons, and although we cannot in most instances, as Prof. Huxley has forcibly pointed out, positively, or even approximately, correlate, as far as age is concerned, distantly separated formations, we can to a very great extent correlate the cosmical conditions under which the formations in question were deposited. The correct determination, therefore, of all organic remains is one of the greatest importance.

Unfortunately for the development of the science, the doctrine that identical specific forms cannot, or ought not, occur over widely separated areas has taken root in the minds of a few of the most eminent scientific investigators, the baneful effects of whose authority in relation to this special line of research, will be encountered by the student at almost every step in his investigations. The science of geographical palæontology, at least as far as the invertebrata are concerned, may be said to be in this country still in a state of infancy, a circumstance partly due to the limited number of workers in the field, and partly to the influences just stated.

I have endeavored in the following pages to summarize as nearly as possible the results obtained from a series of comparisons between the Eocene mollusca of Western Europe and that of the Southeastern United States, undertaken with the view of determining with a certain amount of precision the number of identical and very nearly related species. My comparisons were in a number of cases made between actual specimens, and those mainly determined in the localities to which they belong: where no speci-

culatum, Lam.; *Bulimus* (Niso) *terrellatus*, Lam.; *Sigaretus canaliculatus*, Sow.; *Calyptraea* (*Trochita*) *trochiformis*, Lam.; *Pyrula tricarinata*, Lam.; *Aricula trigona*, Lam.; *Cytherea cryocoides*, Lam.; *C. suberycinoides*, Desh.; *Corbis lamellosa*, Lam.; and *Fistulana elongata*, Desh., most of which on examination prove to be as well American as European forms. In the Appendix to Morton's Synopsis ("Synopsis of the Organic Remains of the Cretaceous Group," 1834) only six European species are recognized as occurring in the American formation: *Solarium canaliculatum*, Lam.; *S. patulum*, Lam.; *Bulimus terrellatus*, Lam.; *Cardita planicosta*, Lam.; *Corbis lamellosa*, Lam.; and *Fistulana elongata*, Desh. In the list published by Conrad in 1846 (Amer. Journ. Science, 2d ser. vol. i. p. 219), of the preceding enumerations only two species are retained as being "analogous" to transatlantic forms, *Cytherea Mortoni*, Con. (*Cytherea cryocoides*, Lam.; and *C. suberycinoides*, Desh.) and *Aricula limula*, Con. (*A. trigona*, Lam.), but in addition we have five new ones catalogued: *Cardita Blandingi*, Con. (*C. aculeicosta*, Lam.); *C. rotunda*, Lea; *C. asperula*, Desh.; *Cardium Nicolleti*, Con. (*C. semigranulosum* [= *granulatum*], Sow.); *Turritella Morton*, Con. (?), and *Rostellaria laqueata*, Con. (*R. fissurula*, Lam.). Finally, all species considered identical prior to 1866 are rejected as such with one exception: *Cardita planicosta* in the Smithsonian List. The reasons for so doing, which, in the majority of cases, I believe, are not stated, appear to me incomprehensible.

In the introduction to his "Contributions to Geology," 1863, p. 19, Mr. Lea states that he is "not perfectly satisfied that a single species is strictly analogous to those from the Eocene Period of Europe", but in a note (pp. 207, 208) makes the following comparisons: *Pasithca umbilicata*, Lea, with *Bulimus terrellatus*, Lam.; *Venericardia rotunda*, Lea, with *V. squamosa*, Lam.; *Pectunculus obliquatus*, Lea, with *P. naevis*, Desh.; *Ostrea decaricata*, Lea, with *O. labellula*, Lam.; and *Solen Blanfordii*, Lea, with *Solen effusus*, Lam.

The list herewith appended, and which it is my intention to complete at a future date, will, I trust, increase our knowledge on the interesting questions of relationship and geographical distribution.

Ostrea divaricata, Lea. "Contributions to Geology," p. 96, pl. 2, fig. 69.

O. sellaformis, Conrad, *para*?

This oyster is referred without doubt both by Nyst (*Coquilles et Polypiers Fossiles*, 1843, p. 323) and Giebel (*Repertorium to Goldfuss' Petrefacta Germaniæ*, 1866, p. 41) to the *O. flabellula* of Lamarck, which is a very variable, and one of the most widely diffused forms of fossil oyster. It is cited by D'Orbigny (*Prodr. de paléon.*) as occurring at Claiborne, Ala., and by Deshayes (*Animaux s. vert., bassin de Paris*) also at Cutch in India and Cairo in Egypt.

Pecten Deshayesi, Lea. Contr. p. 87, pl. 3, fig. 66

(*et P. Lyelli*, acc. to Conrad?).

This *Pecten* is referred with but little doubt by Nyst (*Coqu. et Pol.*, p. 288) to *P. opercularis*, Lamk., which species, however, belongs to a much more recent period than the Eocene of Alabama. On the assurance of identity Nyst in 1836 founded upon a new Belgian *Pecten* the specific name of *Deshayesi*, but his fossil must be carefully distinguished from the American one in question. Having seen but one example of Lea's species I am unable to make the proper comparisons.

Cardita rotunda, Lea. Contr. p. 70, pl. 2, fig. 48, as *Venericardia*.

This species very closely resembles the *Cardita imbricata* of Lamarck, to which, in the absence of specimens, it is with some hesitation referred by Nyst (p. 209), and also by Bronn (*Index Palæontologicus*, I. 226). The only difference that I could detect between the two species, on an examination of numerous speci-

ber of its costa (about 29 instead of 34), but on an examination of numerous French specimens I found the number to be frequently only 29.

Cardium Nicolleti, Conrad. J. A. N. S., viii. p. 190.

This *Cardium* will, I believe, on close examination prove to be the *C. semigranulatum* of Sowerby (Mineral Conchology, II. p. 99). It does not differ from a species of *Cardium* in the Academy Museum marked "*C. semistriatum*, London Clay," but as the *C. semistriatum*, Deshayes, differs in the arrangement of its granulated striae from the specimen in question marked *semistriatum*, and as the last agrees in characters with the description accorded by Sowerby to *C. semigranulatum*, it is highly probable that the names have been simply reversed.

Corbis Gafrarium *hirata*, Con. A. J. Science, I., 2d ser. p. 401.

This species was originally described by Conrad as the *C. lamellosa*, Lam., with the characters of which it was found to agree in all essential respects. I have been unable to note any material difference between the two species in question, and do not hesitate, after an examination of a number of specimens representing Lamarck's type, to unite the two under the one specific name of *lamellosa*.

Limopsis ellipsis, Lea. Contr. p. 78, pl. 3, fig. 56, as *Pectunculus*.

This species closely resembles in general characters the *L. (Stalagnum?) Nysta* of Galeotti, from which it mainly differs in the greater number of teeth both in the anterior and posterior series, the number in each series rarely falling below twelve.

Limopsis aviculoides, Con. Foss. Shells of Tert., p. 39, as *Pectunculus*.

(*Pectunculus obliquus*, Lea.)

Brönn (*Index Palæont.*, ii., p. 936) allies this species with the *Limopsis nana* of Deshayes, from which it differs very materially in the greater elevation of the umbones and cardinal region. Nyst considers it as closely related to *Trigonocaulia auritoides*, Gal., but the obliquity in form is much greater in the American species. It differs from the *Limopsis aurita* of Sassi (*Arca aurita*, Brocchi, "*Conchologia Fossile Subapennina*," ii., p. 485) in having a crenulated margin.

Corbula oniscus, Con. A. J. Science xxiii., p. 341.

(*C. Marchionii*, Lea.)

This species is referred by Brönn (*Index Palæont.*) to *rugosa* of Lamarck, to the description of which, as

hayes (*"Coquilles Fossiles,"* l., p. 51) it agrees in all essential respects. As in the case of the French species it frequently resolves itself into two layers, the inner of which may at first sight be readily mistaken for a new species (*C. bicostata*? Nyst). The *C. gibba*, Olivi, which, according to Nyst, is the equivalent of *C. Murchisonii*, Lea, is a Miocene (?), Pliocene, and living species. I have been unable to institute direct comparisons for want of specimens.

Cytherea Mortoni, Con. J. A. M. S., vii., p. 160.

This species of *Cytherea* was originally confounded by Conrad with the *C. erycinoides*, Lam. (Foss. Shells of Tert., 1832, p. 34), but a close examination shows the latter to be comparatively more elevated, and its ribs to be proportionately much more robust.

Trochita trochiformis, Lea. Contr., p. 96, pl. 3, fig. 76.

This species, described as new by Mr. Lea in 1833, is synonymous with *T. (Calyptræa) trochiformis* of Lamarck (*Trochus apertus*, Brand.).

Cylichna galba, Con. Foss. Shells of Tert., p. 34, as *Volvaria*.
(*Bulla St. Hillairii*, Lea.)

This species appears to me to be erroneously referred by Bronn to *Bulla constricta*, Sow. (Miner. Conch., vol. v., p. 96), as Sowerby's species has no fold on the columella, at least no mention is made of it in his description, nor does it appear in his figure. Our species appears to be closely allied to if not identical with *Bulla Brocchii*, Bronn, an Italian (Miocene?) species (Brocchi, *Conch. Foss. Subapenn.*, ii., p. 257, as *Bulla ovulata*? Lam.).

figure of *Actæon simulatus* (*Bulla simulata*, Brander) leaves no doubt that the two species are identical. Nor does a comparison of actual specimens, from Alabama and Barton, England, show any varying characters.

Fusus (Bulbifusus) inauratus, Con. Foss. Shells of Tert., p. 29.

This species is more closely allied to *F. bulbiformis*, Lam., than to *F. ficulneus*, Lam., to which last it is doubtfully referred by Bronn (p. 512). It differs from the former, however, in having the canal more produced, in the whorls being strongly subangulate above, and in the superior ones being crenulated on their basal margins.

Pyrula penita, Con. Foss. Shells of Tert., p. 32.

P. tricarinata, Con.

P. cancellata, Len.

P. elegantissima, Len.

I am disposed to consider the above as identical with *Pyrula nevillæ*, Lam. (and var. *P. tricarinata*, Lam.), which is a most variable fossil. Both American and European forms appear in the most diverse stages of convexity and angulation. Conrad, although he subsequently separated the transatlantic forms into two distinct species, states (Foss. Shells of Tert., 2d ed., p. 39), "that the variety is not distinct I am assured by comparison of many specimens." I am also inclined to unite with the above the *P. (Fusus) Mississippiensis*, Con.

Oliva bombylis, Con. Foss. Shells of Tert., 2d ed., p. 42.

(*O. constricta*, Len.)

Differs from the *O. nitrocola*, Lam., in having the plications at base less numerous and somewhat less regular, and in wanting the upper of the two impressed revolving lines on the body whorl. In the absence of the line it agrees more closely with *O. nitidula*, which was separated by Deshayes from the *O. nitrocola* as a distinct species. The *O. Brocchi*, Bronn (*Voluta aspidula*, L., var. *Brocchi* "Conch. Foss. Subapenn.," ii., p. 315, pl. iii., fig. 16), which is as well a Miocene, and perhaps even living species (Bronn, iii., p. 481), appears to be very clearly related to our species.

Cancellaria tortiplica, Con. Am. Journ. of Conchol., vol. i., p. 211.

On an examination of specimens of this species and *C. erulæ*, Brander (from Barton, England) I find the two to be most intimately allied to each other, the main difference being that the *C.*

tortiplica is somewhat more slender and elevated. As this may be only an accidental feature in the few examples which have come under my notice, I feel but little hesitation in uniting the two as one species. Bronn and Nyst (p. 477) refer with some doubt the *C. parva* of Lea to Brander's type, but this diminutive Alabama species has only two plaits on the columella, and is destitute of varices.

Niso umbilicata, Lea. Contr., p. 103, as *Panithes*.

Niso torbellatus, Lamk.

I have been unable to detect the slightest difference between specimens obtained from both species.

Sigaretus canaliculatus, Sow. Min. Conch., iv., p. 116.

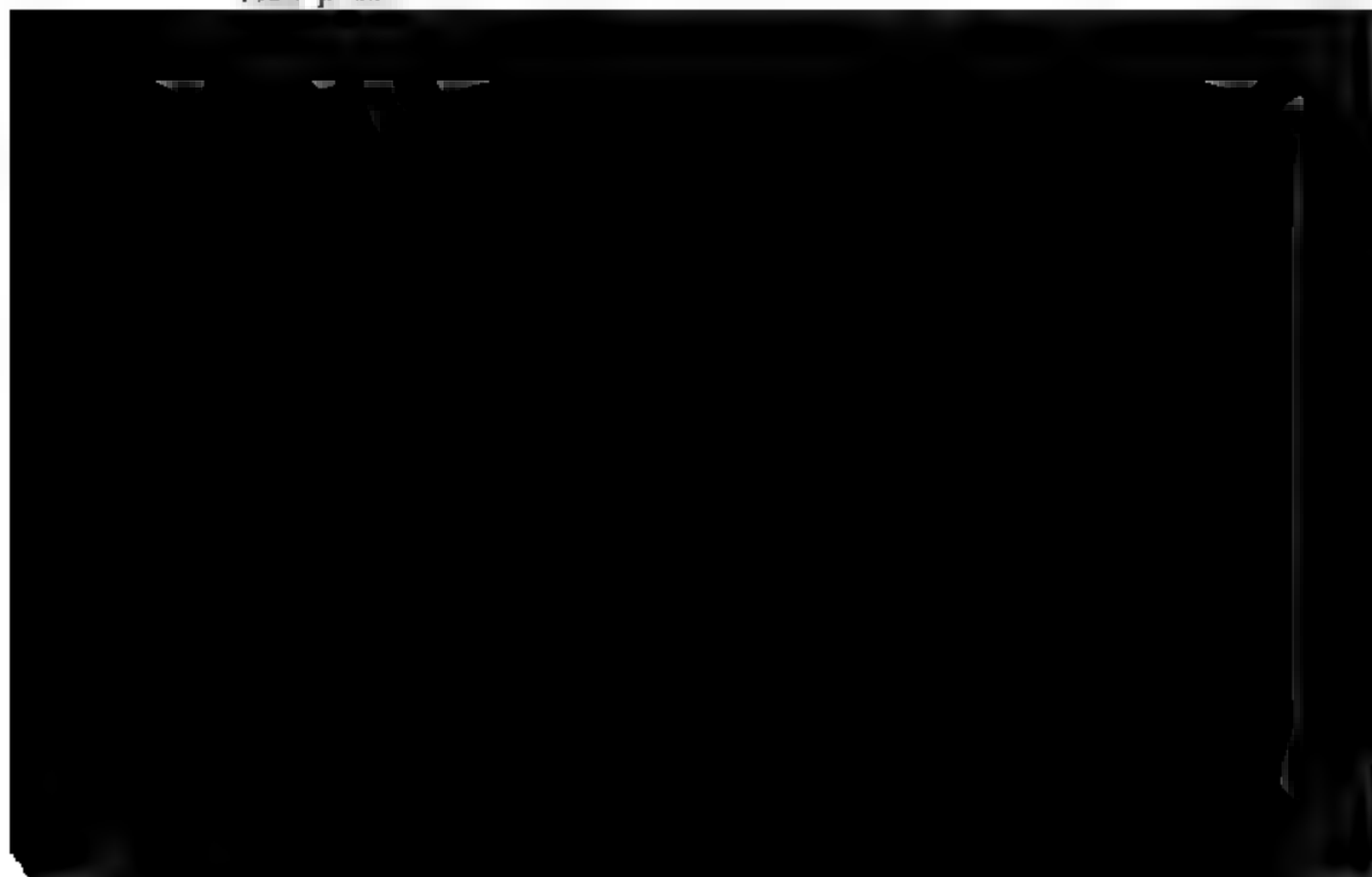
This shell is mentioned by Conrad (Foss. Shells of Tert., 2d ed., p. 34) as occurring at Claiborne, Ala. It is probably identical with *S. declivus* and *S. biliz*, Con., which differ among themselves about as much as they do from the European species.

Solarium ornatum, Lea. Contr., p. 120.

This species is placed without doubt by Bronn (ii., p. 1153) as synonymous with *S. canaliculatum*, Lam. The description and figures as given by Deshayes (*Coqu. Foss.*, ii., p. 221) answer perfectly to the American species, and I feel no doubt but that an examination of specimens of both species will prove their identity.

The *S. canaliculatum* is mentioned by Conrad (Foss. Shells of Tert., 2d ed., p. 34) as occurring in the Alabama Eocene deposits.

Pleurotoma denticula, Bast. Descrip. Géol. du Bass. Ter. Sud-ouest de la France, 1823, p. 63.



atlas, pl. 11 (20) fig. 8) to North Italy (Bellardi "*Monog. Pleurot. Foss. del Piem.*," *Memorie della Reale Accademia di Torino*, 2d ser., vol. ix., p. 576). This species corresponds probably to some extent with Sowerby's *P. comma*. Unquestionable specimens of *P. denticula* from the Eocene of Alabama are to be found in the American Museum of Natural History of New York.

Mecostoma rugosa, nob. Proc. A. N. S., Oct. 1879.

This species might readily be mistaken for the *M. grata*, Desh., of the Paris basin, from which it differs only in the greater number of its revolving ridges.

Melania Claibornensis, nob. Proc. A. N. S., Oct. 1879.

This diminutive *Melania*, which to my knowledge constitutes the only essentially fresh-water gastropod found to the present time in the Claiborne marine formation, cannot in its characters be readily distinguished from the *M. mixta*, Desh., of the Paris basin (description and fig. in Desh. "*Animaux s. vert.*"). Having observed but one specimen, and not wishing to definitely deduce its affinities from the characters drawn from a single example, I have provisionally applied to the American shell the specific name which it bears above.

A close comparison of the Eocene mollusca of the east and west Atlantic shores will, I am confident, reveal a larger number of identical forms than those enumerated in the above list. The *Naticidae* and *Pectunculidae*, two families requiring acute revision, appear more especially to be intimately related in their specific forms.

REVISION OF THE PALÆOCRINOIDEA.

BY CHARLES WACHSMUTH AND FRANK SPRINGER.

INTRODUCTION.

According to Miller's catalogue of American paleozoic fossils, there have been described, in this country alone, up to the summer of 1877, about 800 species of Crinoids, not including Blastoids and Cystideans. If we add to this number some 400 species from Europe—an estimate which is certainly not exaggerated when we remember that Schultze described from the Devonian of the Eifel alone 73 species; DeKoninck and Le Hon from Belgium 45; and Angelin from the Silurian of Sweden 176—we have from both countries about 1250 species. Making due allowance for synonyms, we have possibly 1000 good species, which are distributed among from 150 to 175 genera. Many of the latter were established at a time when our knowledge of the Crinoids was in its infancy. They were frequently founded upon one or two species, often, indeed, on a single imperfect specimen; which resulted in many defective, insufficient, and not unfrequently incorrect descriptions, producing endless perplexing complications afterwards.

There was a time when nearly every fossil Crinoid was *Encrinurus*. This was the case almost until 1821, when J. S. Miller described his well-known genera *Poteriocrinus*, *Actinocrinus*, *Platycrinus*, *Rhynchocrinus*, and *Cuthocrinus*, which have been uni-

ontologists, but by some entirely ignored. It is a singular fact that European authors have commonly refused to accept our genera of *Actinocrinidæ*, while they sustained those of the *Cyathocrinidæ*, which are certainly no better defined. This is doubtless due to the fact that in Europe the *Actinocrinidæ* do not abound in such wonderful variety as in this country. If our European brethren had to deal with nearly 300 species, as we have, they would perhaps be more ready to accept our divisions.

As early as 1842 T. Austin and T. Austin, Jr. (Rec. & Foss. Crinoidea), undertook to subdivide the Crinoidea into families, but they were not very successful, as they placed together types of very distinct groups. Roemer (*Lethæa Geognostica*, 1855, 3d Ausgabe) made another attempt in the same direction. He was the first author who pointed out correctly the relations of the Blastoids and Cystideans with the true Crinoids; and, if he was not so fortunate in establishing his families, we must consider how imperfectly Crinoids were known at that time. Some of Roemer's family names are still in use, but scarcely two of our present authors interpret them alike.

The late Prof. Angelin¹ divided the Silurian Crinoids of Sweden into four sections: *Trimera*, *Tetramera*, *Pentamera*, and *Polymera*. A subdivision according to the number of basal plates may facilitate elementary studies, but it is certainly not a natural classification. Genera which are evidently intimately related—for instance, *Platycrinus* and *Dichocrinus*, *Melocrinus* and *Rhodocrinus*—are thereby widely separated, while very distinct types, such as *Rhodocrinus* and *Poteriocrinus*, are brought together. Angelin arranged his 40 genera of Swedish Crinoids under 23 families; but, as he gave no diagnoses of them, we are at a loss to know upon what principle his families were established.

In the second part of an article on the "Internal and External Structure of Paleozoic Crinoids," by Chas. Wachsmuth, published in the August and September numbers of the Amer. Journ. Sci., 1877, one of the writers gave a minute description of the summit

¹ In the *Iconographia Crinoideorum in stratis Sueciæ Siluricis fossilium*, auctore N. P. Angelin, opus posthumum edendum curavit Regia Academia Sueciæ, cum tabulis XXIX. This is one of the finest illustrated works on Crinoids that has ever been published, and it must be regarded as a great loss to science that the distinguished author died before the completion of his work.

or ventral disk of the earlier Crinoids, and reached the conclusion that the construction of the vault affords good characters for a separation into families. He distinguished three principal plans—though he admitted the existence of a number of others—upon which the summit is constructed:—

1. The summit composed of a more or less pliable, sometimes perhaps squamous, integument, yielding to motion in the body and arms.

2. The summit composed of solid plates with a porous ventral sac, located posteriorly on the disc, and closed at the top. Anal opening rarely observed, but probably lateral.

3. The summit composed of heavy immovable plates, closely joining and forming a dome arching the entire oral side. Anal opening directly through the wall of the dome or at the extremity of a tube, the so-called proboscis.

We have since given this subject our special attention, and find that these diversities in the construction of the ventral portion of the body bear a striking relation to the general arrangement of the plates of the dorsal side; that the parental genera to which we have referred have each their own peculiar summit structure, and that the genera into which they were subsequently subdivided are characterized by mere differentiations of the original plan. We find that *Ichthyocrinus* and its congeners, *Taxocrinus*, *Mesopilocrinus*, etc., which are embraced in almost the same generic formula, possess summit structure No. 1; that in *Cyathocrinus*, *Poteriocrinus*, *Heterocrinus*, and all genera with five basals, five subradials, and five radials, the summit structure agrees with No.

tome of recent Crinoids, the vault being thus a mere covering or protection. That the mouth was internal in the majority, if not all paleozoic Crinoids, as well as all the Cystideans and Blastoids, is very significant, and impresses us most forcibly with the idea that the earlier Crinoids form a distinct group, and that the solid covering may have been essential under the conditions that prevailed in paleozoic times.

The genus *Lichinocrinus*, which Hall describes from the Lower Silurian of Cincinnati, affords an instructive example in this respect. In this interesting form, the oral or ventral side was always attached to a shell, coral or other foreign substance; the dorsal side has a long stem, but whether this was attached to the bottom or not, is not known. The oral side, when found detached, which is of very rare occurrence, shows a large number of striae, which converge to a very small opening in the centre. According to our interpretation, this opening is the mouth, the striae the food passages, and the shell to which the ventral side is attached, takes the place of the vault, which is as yet undeveloped.

Another very characteristic distinction between ancient and recent Crinoids is to be found in the comparatively large size and massive body plates in the fossil, contrasted with the diminutive body and very long and highly developed arms of recent types; and the same is even more strikingly true as to Blastoids and Cystideans. To illustrate, we might say that in the *Pentacrinidae* they are fully developed; that they are in progress of growth in paleozoic Crinoids, and that they are only budding or sprouting in Blastoids and Cystideans; while in *Lichinocrinus*, which is probably still lower in the scale of organization, the arms have not yet made their appearance.

Upon these distinctions, principally, Wachsmonth (Am. Journ. Sci., Sept. 1877, p. 190) proposed to separate the paleozoic from the recent Crinoids, under the name PALEOCRINOIDEA, as a sub-order of the Crinoids, of equal rank with the BLASTOIDEA and CYSTIDEA.

To facilitate a better understanding of the two groups, we now direct attention to certain organs which have been known to exist in Cystideans and Blastoids, and which we think existed in a modified form in the Paleocrinoids. These organs, which were called "hydrospires" by Billings (Am. Journ. Sci., July, 1869, p. 75), occupy rather large spaces within the body in the first-named

groups, and this may perhaps explain in a measure the comparatively large size of the calyx in the older Crinoids generally. The hydrospires were located within the perivisceral cavity, connected with the inner floor of the test, and communicated, so far as ascertained, through the test with the outside water. In the Cystideans the hydrospires are of a rhomboidal shape—each rhomb being divided into two triangles by a suture between two of the plates (Pl. 17, Figs. 7, 8.). In *Caryocrinus ornatus*, each of the four sides of the rhombs is bordered by a row of small tubercles (Pl. 17, Fig. 6), some of which have a single pore in the apex, while others are perforated by two to twenty or more. The pores penetrate through the plates, but do not communicate directly with the visceral cavity of the body. Internally, each hydrospire consists of a number of flattened tubes, arranged parallel to each other, and each tube receives two of the pores, one at each end. In a large hydrospire, there are about twenty or more tubes. Whatever may have been the special function of these tubes, naturalists generally agree that they belong to the respiratory system, and we infer from the distribution of the pores in variable numbers at and about the apices of the tubercles, that they very probably served as a madreporic apparatus, through which water for respiration was introduced and expelled. In other genera of the Cystideans, we find in the test one or more striated rhombs with fissures and pores, somewhat resembling the madreporic body of other Echinoderma.

In the Blastoids, there are certain orifices arranged around the actinal pole, which have been called ovarian apertures on account of their supposed resemblance to similar openings in the Ophiu-



inner side of the forked plate. In most genera, they are constructed upon the same general plan. There are ten sacs (compare Pl. 17, Fig. 5) which do not connect with each other, disposed in pairs, one pair to each ambulacrum, and each pair separated by the lancelet piece. Toward the visceral cavity, they are folded into a number of longitudinal plications, which show neither pores nor passages. The inner and outer folds alternate with each other, and are distended at their closed ends. On approaching the apex of the body, they coalesce to form two separate sets of tubes. The tubes from the inner folds are formed by the adhesion of the walls of the outer, and, *vice versa*, so that the folds which open toward the visceral cavity give rise to the outer set of tubes, while those opening in the opposite direction become the inner tubes. The former terminate within corridors leading to the so-called ovarian orifices, those of each two adjoining hydrospires of two different ambulacra terminating in one orifice; while the latter communicate with an annular organ located against the inner wall of the test and surrounding the oral centre. The number of folds varies from three to nine or more. The walls of the sacs, which were evidently composed of fine membranous substance, must have been strengthened by the secretion of calcareous particles, or they would not be found so well preserved; and they were flexible since we find the folds in various degrees of expansion. In *C. cluster*, one of the earliest and probably one of the lowest type of the Blastoids, and in *Cobourbs*, its subcarboniferous representative, there is in place of the folded sacs a large number of tubes placed side by side, and arranged parallel with the external fissures or grooves. This structure of the hydrospires so closely resembles that of some of the Cystideans that Billings proposed to remove *Cobaster* from the Blastoids and place it among the Cystideans. This we cannot endorse, but we do agree with him, that whatever may have been the functions of the calycine pores, pectinated rhombs, and internal tubes in the Cystideans, those of the parallel tubes or folded sacs in the Blastoids must have been very similar if not identical.

1 We have given above the description of the hydrospires in *Pentremites*. Those of *Granatocrinus* and *Nucleocrinus* vary in some of the details. One of us, who devoted much time to the study of the Blastoids, made a large number of sections of the hydrospires, in different 1 ends

distinction the latter from recent Crinoids, at the same time indicating a closer relationship with the Cystideans.

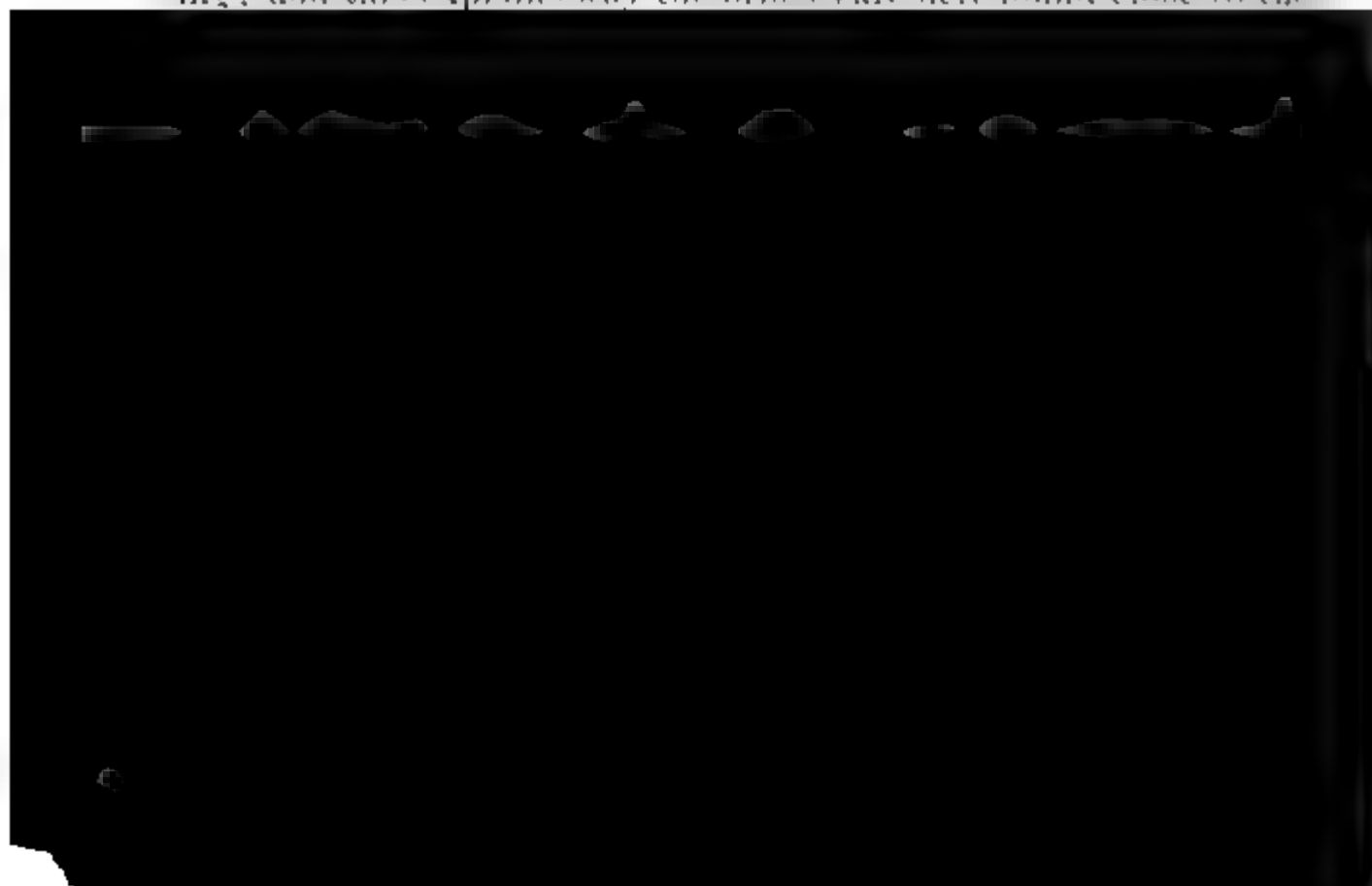
Wachsmuth, in Am. Journ. Sci., Aug. 1877, marked difference between the proboscis in the *A.* that in the *Cyathocrinidæ*. He considered the anal tube, or prolongation of the anal opening; in the *Cyathocrinidæ* he believed to be an essential in which the anal opening, here located laterally of but secondary importance, and therefore proposed a "ventral sac" instead of proboscis. We have since to examine the ventral sac in several most especially with reference to the pores to which it opens, and have become convinced that these are homologues of the calycine pores in the Cystideans. The pores of the ventral sac in the *Cyathocrinidæ* are usually large, rather thin, hexagonal pieces, longitudinally arranged with those of the adjoining rows. The plates meet at each angle. It is now very interesting in some species—for instance, *Poteriocrinus Missillii* Pot. (*Scaphiocrinus*) *unicus* Hall, there are in the plates slit-like fissures of considerable length. Four or sometimes six—connect with those of the plate row, those of each half of a plate meeting corresponding two different plates, so that one half of the fissure opens upward and the other downward. We have filed several specimens, and have found that the fissures pass through them, and in many cases, where they ha

the fissures occur not only at the lateral, but also at the upper and lower sides of the plates, meeting here in like manner with the slits of the adjoining plates. In species in which the plates are provided with three slits to a side, the median one is larger than the other two, thus forming with the corresponding slits of the adjoining plate the figure of a quadrangle or rhomb, divided into two triangles, exactly as Billings describes the parallel canals which compose the hydrospires in *Caryocrinus*. Indeed, the similarity which seems to exist in this respect between the two groups, is so striking, that we can scarcely doubt that both structures were adapted to the performance of the same functions. It is true that the hydrospires in *Caryocrinus* are located on the aboral, and in the *Cyathocrinidæ* on the oral side of the body, but it must be remembered, as already shown (Am. Journ. Sci., Sept. 1877, p. 190) that the entire test of paleozoic Crinoids forms a part of the abactinal system, and the position of the hydrospires in Cystideans is by no means confined to the aboral side, nor to the oral in Paleocrinoids. We find in the genus *Porocrinus*, Billings, which forms a kind of link between Cystideans and Paleocrinoids (the arrangement of the plates of the calyx is exactly like that of all *Cyathocrinidæ*), that the hydrospires are altogether confined to the calyx. In the sutures between the plates, there exist a number of striated, poriferous areas, resembling the pectinated rhombs in their structure, and though their form and position are somewhat different from those of any other known Crinoid or Cystidean, there can be no doubt that they performed in the animal the same office. Unfortunately we do not know whether this genus had a poriferous ventral sac; nor have we been able to ascertain whether the longitudinal depressions on the ventral sac which we have noticed above, were covered—perhaps by perforated plates, such as Billings observed upon the tubercles of *Caryocrinus*—or only the pores and fissures, but we are inclined to think the former was the case, since we found in some other specimens of *P. unicornis*, no depressions, but at the same time no fissures nor pores.

In many of the *Actinocrinida*, *Platycrinida*, and *Rhodocrinida*, which are provided with a simple anal tube or an anal opening directly through the vault, the respiratory organs were probably located within the main body, at least there are many facts which seem to indicate this. In an article on page 248 of the Proceedings of the Acad. Nat. Sci. Phila., 1878, we noted the existence

of certain pores or openings located between the arm bases and separated from the arm passages by a thin partition. Their number varies from ten to twenty or more. In *Batocrinus*, where they are most conspicuous, there are twenty, no matter whether the species has more or less than twenty arms. They are about one-third the size of the arm passages, with which they are in very near the same horizontal plane. There are two pores to each interrarial field, one to the left of one arm, and one to the right of another. Ten other pores have a radial position, two within each of the five axillary spaces which form the median portion of the rays. In *Strotocrinus*, which has an enormous body, each arm has a pore, and so in *Steganocrinus*, *Eucladocrinus*, and apparently in all genera in which the arms branch off alternately. Other genera have only ten pores. In *Ollacrinus* the pores are represented by two longitudinal passages through the tubular extensions of the interrarial series, or the false arms as usually called.

As these openings, especially in *Batocrinus*, are comparatively large, it is somewhat surprising that they have never been mentioned by other paleontologists. Their position corresponds almost exactly with that of the so-called ovarian apertures of the Blastoids though they are placed at a greater distance from the radial centre. The openings in both groups are situated within the brachial zone or at the extreme border of the summit. In the Blastoids the ventral disc or summit is reduced to the minimum in size, being composed only of the covering of the ventral opening; and this explains why the orifices are here found close to the



apparatus. Whether the above described pores communicated with these chambers cannot be determined from the fossil, but we may perhaps infer this from their position, and also that the chambers themselves were or contained organs similar to those described as hydrospires in other groups of the Crinoidea.

Folded sacs or parallel tubes, as in the Blastoids, have not hitherto been noticed in the Palæocrinoidea. That they existed in some groups of the latter is almost certain. The so-called "consolidating apparatus" of *Cupressocrinus* (Pl. 17, Fig. 3) is in our opinion a true set of hydrospires, arranged in pairs exactly as in Blastoids, but spreading out horizontally instead of vertically. Angelin (Iconogr. Crin., Pl. VIII. Fig. 7, *a, b*) figures a *Crotalocrinus*, in which the consolidating apparatus—or hydrospires, as we believe—is most excellently preserved. Even the inner tubes can be traced, and, if there existed still a doubt whether the closely related *Cupressocrinus* had its ventral side firmly closed, Angelin's figure, Pl. VIII. Fig. 6, ought to remove it. There seems to be in *Crotalocrinus* not only a solid integument covering the entire ventral disc and inclosing the hydrospires, but we judge from Fig. 7 of the preceding plate, that the oral centre or median space between the hydrospires had even a double covering.

It seems to us that there can scarcely be a doubt but that the consolidating plates of *Cyathocrinus* (Pl. 17, Fig. 2) are homologous with the oral plates of the Pentaerinoid larva (Pl. 17, Fig. 1), and ought to be designated as such; and further, that the so-called consolidating plates of *Cupressocrinus* are the homologues of the deltoid pieces of the Blastoids (Pl. 17, Fig. 4). It will be seen that all four occupy the same relative position in the respective types. There are five interradial plates, which join at their sides, extending inward, but so as to leave an opening at the oral centre. The affinities, indeed, are so striking that we think it not unreasonable to suppose that the hydrospires are metamorphosed oral plates. The construction of the deltoid pieces is very complicated, only the median or deltoid portion being visible externally. They are extended laterally, in spade-shaped appendages (Pl. 17, Fig. 4), which pass under the ambulacral fields and are hidden by them. To these appendages the sides of the hydrospires are attached, being suspended on each side of the ambulacrum, or modified arm, and partly covered by

it. In the so-called consolidating plates of *Cupressocrinus* we find precisely the same structure. Each plate has lateral extensions, each of which supports a set of folds which incline in opposite directions. The number of folds varies in different species, *Cupressocrinus abbreviatus* having apparently seven, and *C. gracilis* but two or three, and so in the Blastoids, *Pentremiles pyriformis* has seven folds and *P. Godoni* but five. As the folds of two different plates are not connected laterally, a sort of depression or groove is formed in a radial direction, which evidently contained the food passage, covering the sutures between the plates as the pseudambulacral folds cover those of the deltoid pieces in the Blastoids. The so-called consolidating plates with their folds, of *Cupressocrinus*, and the deltoid pieces with their appended hydrospires in Blastoids, being not only analogous in position but also almost identical in structure, it is very evident that they had a similar office in the animal organism, and that if these organs in Blastoids were respiratory, the hydrospires in *Cupressocrinus* and *Crotalocrinus* had the same functions.

This view of the relations of the parts under consideration suggests a possible analogy in the general structure of Blastoids and Paleocrinoids, in which we may consider that the ambulacrum is a recumbent arm; the lower part of the forked plate up to the ambulacrum is the first radial—in *Blastoidocrinus*, the oldest known Blastoid, the suture is visible—that the two sides of the fork, instead of being interradial, form together a second radial, and the small summit plates are homologous with those which cover the central opening between the oral plates in *Cuthocrinus*, or to

in which no trace of them has as yet been discovered. These include among others the *Ichthyocrinidæ*, and a few genera of the *Actinocrinidæ* and *Cyathocrinidæ*. In the *Ichthyocrinidæ*, respiration may have been carried on through the pliant vault, aided by the expansions and contractions which the flexible nature of the skeleton could produce. In the *Actinocrinidæ*, however, the body, as in the Blastoids, is perfectly rigid, the plates heavy and firmly cemented together. There are no other openings in the body but the anal aperture, the arm passages, a passage through the column and the pores between the arm bases which we have described. In some genera, however, the last-named pores apparently do not exist. The introduction of water through the anal tube need not be considered for a moment, nor through the arms, which in no group of the Echinoderms perform such an office. Let us examine the column.

The construction of the column varies in different genera. It is perforated throughout the centre by a passage connecting with the interior of the body, which in some cases is a simple, small, round opening, while in others it is very large and marked by a peculiarly complicated internal structure. In the latter, the tubular cavity extends to all the branches which spring off rather numerous toward the root. It is mostly pentamorous, though in some cases tri- or quadri-partite; it is sometimes regularly pentagonal, and sometimes divided into five petaloid chambers which unite at the centre. The walls within appear as if built up of thin laminae, with spaces between, sometimes pectinated, and variously sculptured, all producing a great multiplication of exposed surfaces. In some the articulating faces of the stem segments are covered with striae, radiating from the centre, which resemble minute pores penetrating the walls. We have found the very base of one of these large columns just as it was attached to the rock or other flat surface. It is very broad and deeply channelled on the bottom, and there are numerous branches or unattached cyrri, all of which are perforated, and through which there was ample communication with the surrounding water. In addition to this, there are large pores near the base of the column, leading from without into the main cavity directly through the walls.

Such an extraordinary structure was not necessary, if the column was merely an attachment or anchor for the Crinoid. That it was a means of communication between the water outside and the in-

ternal organs of the body for some purpose we entertain no doubt, and the large amount of surface exposed by means of the complex lamellar structure, is strongly suggestive of the principle which prevails in the respiratory apparatus in the animal kingdom generally. We have said that some *Actinocrinidæ* probably do not possess the pores in the body. It is very significant that it is in these very forms that we find columns such as we have just described. Indeed, in general, so far as we have been able to observe, we have found it to be the rule, that those types which have a perforated ventral sac are without pores in the calyx; that those with calycine pores do not possess a perforated ventral sac, and that in forms with a flexible vault, or with perforated ventral sac, or with pores in the body walls, the column is generally destitute of any such complex structure, and has only a small, simple aperture. There may be exceptions to this; in fact we know of some, but these relate exclusively to very large species, in which the openings in the main body, which we suppose to be respiratory passages, are inadequate to supply the immense body. The most remarkable examples of this kind are *Megistocrinus* and *Barycrinus*. The former, which belongs to the *Actinocrinidæ*, has species with larger bodily capacity than has been discovered in any other genus. It has generally only ten primary arms, and most probably only ten respiratory pores in the body. *Barycrinus* attains by far the greatest size of the *Cyathocrinidæ*, and the column of this genus like that of *Megistocrinus* is not only very strong, but its central cavity is exceedingly large and complicated. We thus have in these two genera apparently another mode of communication from

Herbert Carpenter, in a valuable paper (Quarterly Journ. Sci., vol. xviii (new series), p. 351), on the "Oral and Arms of the Echinoderms," undertakes to determine the relations between that system of plates in the calcareous skeletons known as apical plates, and certain parts of the Crinoids, both recent and fossil. He considers the basals of Crinoids to be homologous to the genital plates, and the subocular plates of the Echini, and he traces the homologies in the Palæocrinoidea, in respect to which, however, he adopts the opinion that the first ring of plates resting upon the stem segment, which have heretofore been nominated basals, in many types not basals at all. He regards the set of plates which lie next below the radials as the true "basals," whether they rest directly upon the stem, as in *Platycrinus*, or are separated from it by another ring of plates, as in *Cyathocrinus*; that the "subradials" of most American authors, or "basals" as they are generally termed in Europe, are "basals" in his view. The lowest or proximal ring of plates, including the "subradials," he calls "underbasals," and these he does not see represented in the other types of Crinoids and all Echinoderms. The central plate of the apical system, representing the central disk or subanal plate of the Echini, is considered by Carpenter to be the homologue of the terminal joint of the stem in all pedunculated Crinoids, and in the larva of *Comatula*, and of the central plate in *Mar-*

Crinoids. These views conflict with those of A. Agassiz, who regards the subanal plate of the Echini as the homologue of the centro-dorsal plate of *Comatula*; and both these views are in conflict with the views of Carpenter, who regards the "basals" of the Crinoids, by which term they mean the first ring of plates above the stem in all types. They also conflict with the view of Carpenter, who regards the single plate in the apical system of the Echini as the homologue of the basalia of the Crinoids metamorphosed into one. Carpenter's reasoning in regard to the basal plates is, that, as in the Echini, and the basals in most Paleocrinoids, generally considered to be their homologues, are situated symmetrically with regard to the general symmetry of the body, he expects to find the genitals in Paleocrinoids in the same position; and that in forms like *Cyathocrinus*, which have plates below the radials, the lower or proximal plates

are situated in line with the radials, and hence cannot be the true basals. He holds that the same order of plates cannot be radial in one genus and interrarial in another. This argument is unquestionably a very strong one, and we are enabled to confirm it by a number of interesting observations.

Let us consider the first ring of plates resting upon the upper stem joint in Crinoids, where it consists of less than five, as a metamorphosed representative of a set of five plates, in which two or more have been united by anchylosis. It will be observed that in nearly all types with but one ring of plates below the radials, i. e., forms without "subradials," the proximal ring is so placed that the angles alternate with those of the radials, so that the whole set, whether five plates or not, may very appropriately be considered as *interrarial* with regard to the general structure of the body.

In forms like *Platycrinus*, *Symbathocrinus*, etc., in which the radials rest directly upon a basal disc composed of three unequal plates, if we bisect the two larger, we obtain five equal plates, which occupy an interrarial position. This is actually done in *Belemnocrinus*, which in the apical system has the identical structure of *Rhizocrinus*, and most of the recent Crinoids, viz., five basals, interrariaily situated, supporting five radials.

In *Melocrinus* and *Eucalyptocrinus*, where the proximal ring consists of four plates, we may divide the larger one and thus obtain five plates, which, though not wholly regular in form, are all interrarial in position.

In *Tetracrinus* which has three equal plates in the basal disc,

of the anal series as an element in the structure of many Paleocrinoids, may be largely due to the solid dome, which has to be penetrated by a special aperture, requiring some modification of the general structure below to accommodate it. It seems to have no direct representative in the apical system of the recent Echinoderms, but we may be justified in considering it as a specialized interradiar, and in that case the basals of the forms under consideration are found to conform entirely to Carpenter's interpretation, being interradially disposed. We find a most interesting confirmation of this view in a specimen of *Actinocrinus* (*Strobocrinus*) *umbrosus*, which has abnormally no first anal plate, the first radials joining at their sides. The anal series in form and proportions is very similar to the other interradiars, being chiefly distinguished by having three plates in the second range instead of two, as in the others. Accordingly, we find the basal disc in this specimen reduced to three *unequal* plates, and if we bisect the two larger, we obtain five equal plates, interradially situated, just as in *Platycrinus*. Nature herself, in this isolated specimen, has thus beautifully illustrated our argument. It is well to note in this connection that in *Platycrinus*, and all genera with three unequal plates in the proximal ring, the small plate is never, so far as we have observed, on the anal side, and this is the case with the abnormal specimen above described, the small plate being situated below the suture of the left posterior and lateral rays. Why this is so we are as yet unable to explain.

In forms like *Cyathocrinus*, *Rhodocrinus*, etc., which have two rings of five plates each, the proximal plates are radially situated, and, therefore, according to Carpenter, cannot be basals or homologous to the genitals, but the second ring of plates or "subradials," being interradiar in position, are the true basals and the homologues of the genitals. If, now, we examine those types with two rings below the radials, in which the proximal ring consists of less than five plates, we shall find his idea still further confirmed.

In the *Ichthyocrinida* (except *Calpocrinus*!) which have in the proximal ring three unequal plates, they are so proportioned and so situated that if we divide them by two additional sutures into five about equal plates, *these five will be radially situated*, and exactly equivalent to the corresponding set of plates in *Cyathocrinus*. In *Gissocrinus*, one of Angelin's Upper Silurian genera from Gotland, which is in every other respect a true *Cyathocri-*

nus, there are but three unequal plates in the proximal ring, showing here an actual metamorphosis of five plates into three.

In *Cupressocrinus*, which has a single central plate below the "subradials," pierced by the quadripartite perforation of the column, it might at first seem difficult to subdivide the proximal plate in this manner. But it will be noted that it is really radial in position, since its five external angles alternate with those of the "subradials," and furthermore, we find that nature has done it for us in a precisely similar case. *Myrtillocrinus*, whose base is perforated by a quadrangular foramen, has its proximal ring divided into five small pieces, alternating with "subradials" and hence radial in position. (15th New York Regents' Rep., p. 142.)

It is worthy of note that in the form last discussed—those with two rings below the radials—the proximal plates are almost invariably very small, and in many cases so minute as to be hidden by the column, thus in their insignificance affording an argument against comparing them with the genitals. They seem to be early developed, for they are as large in the young as in the adult, and do not show much increase in proportions in later geological epochs.

In some *Cyathocrinidae*, the proximal ring sometimes attains considerable proportionate size, and it seems to have developed in geological time, for we find in the Lower Silurian genus *Heterocrinus* that this set of plates is represented in an extremely rudimentary stage, being only faintly visible between the sutures of the basals—"subradials"—and these plates seem to be minute in most similar Silurian genera. Yet it must not be overlooked that

well with Carpenter's interpretation, the three basals being divisible into five plates interradially arranged.

All these facts seem to indicate that the "subradials," in genera where they exist, are really the basals, and in such simple forms as *Cyathocrinus*, it seems very reasonable to consider these plates as the homologues of the genitals, and the radials as the ocular plates in the apical system of the Echini. In more complex forms, such as the *Actinocrinidæ*, *Rhodocrinidæ*, *Ichthyocrinidæ*, etc., there would seem at first to be an objection to this interpretation, arising from the fact that there are several other orders of plates, both radial and interradiial, within the body walls, and that in these cases, as in *Cyathocrinidæ*, we should find the homologues of the apical plates of the Echini in the *entire calyx*, or the whole series of plates of the aboral side up to the region of the arms, and not in the two rings alone which Carpenter points out as such; in other words, that the apical plates in the Echini cannot be homologized with some few plates in the calyx of Paleocrinoidea.

In the younger stages of Paleocrinoids, the higher series of radials are unconnected by interradiial or axillary plates, as may be seen most beautifully illustrated in the growth of *Strotocrinus*.¹

It is also probable that at a still earlier period in the life of these Crinoids, the second and third primary radials constituted a free ray, as in the more simply constructed *Cyathocrinus*. In *Actinocrinus*, etc., the basals, which according to Carpenter are homologous to the "subradials" in other families, and the genitals in Echini, develop very early in the young, and attain almost their full size when even the first radials are comparatively much smaller. We have in our possession a *Cyathocrinus*, not more than half an inch in length including the arms and a portion of the column, in which, while the proximal plates are comparatively small, the so-called "subradials" are developed to an extraordinary degree, far more than the radials. The specimen in this stage looks remarkably like Billing's Lower Silurian genus *Hybocrinus*, in which the first interradiial ring of plates is enormously prominent and gibbous, while the proximal ring is apparently wanting, or if it exists, is very minute.

¹ See our paper on "Transition forms in Crinoids," *Proceed. Acad. Nat. Sci. Philad.*, 1878, p. 233, and also pp. 229-235 for illustrations of development in the parts in question in successive epochs.

It is now a very important fact that these two rings of plates—the first radials and the interrarial set of plates next below them—are the only ones which are found in *all Crinoids from the earliest geological ages to the present time*. It thus appears that the evidence derived from the embryology of the Pentacrinoid, and the observed mode and order of development in the Paleocrinoids during individual life, is fully and beautifully confirmed by the geological history of Crinoids.

All this evidence seems to us to be conclusive, and to prove satisfactorily that the two rings of plates regarded by Carpenter as genitals and oculars, are the fundamental parts in the aboral side of the calcareous skeleton, and that the subsequent orders of radials and interradians are to be considered as supplementary to them, and as the products of growth in the individual and development in geological time.

Our conclusions being thus in harmony with Prof. Carpenter's views, we think it both logical and expedient to adopt his terms, and call the first ring of plates below the radials "basals" in all cases, and the second ring below, or the proximal plates when there are two rings, "underbasals," thus discontinuing the term "subradials" altogether.

We cannot, however, agree with Carpenter in supposing, as he does, p. 374, that the underbasals have no representative in the apical system of other Crinoids or Echinoderms. We incline to the opinion of Agassiz, Lovén, and others, that they are homologous with the central disc or subanal plate of the Echini, and with the centro-dorsal plate of *Coelacanth*. In the paleozoic genus

in maturity become free, and a calcareous deposit is secreted around the base, which covers and obliterates the sutures between the plates. Here again we have an actual metamorphosis—during the life of the individual—of five plates into one, and this seems to us to be strongly confirmatory of the views of Agassiz and Lovén. We are inclined to think that the plate within the ring of under-basals when it exists, as in *Marsupites*, represents the column of Crinoids generally.

Having thus discussed the relations and distinctions between some groups of the Crinoids and the differences between the *Paleocrinoidea* and the *Stomatocrinoidea*—so we should like to call all Crinoids which have an external mouth—we think it proper to indicate briefly the principles which we shall endeavor to follow in our more detailed work.

CLASSIFICATION.

In attempting to make a systematic classification of the Paleocrinoids into families and genera, we encounter the difficulties which usually confront us when we undertake to ascertain and define any divisions as they exist in nature. We can readily recognize in groups of fossils certain broad characters by which it seems natural and satisfactory to bring them together, and we generally find in the characteristic types of the respective groups an association of other characters, by which they appear sharply marked; and so long as we have to deal with typical forms in isolated specimens or groups, the work is simple enough. But when we begin to investigate large collections, and in a measure to study comparatively all the known material from specimens or descriptions, we find the subject bristling with perplexing questions. Types are found to shade into one another, characters are commingled through processes of transition, which sadly interfere with the nice definitions we think we have worked out. How to deal with such forms has always been a troublesome question with naturalists, and the diverse methods of treating it have given rise to much confusion. We have found it especially perplexing in endeavoring to define the *genera* of the Crinoids. We find for instance, two groups, each embracing a number of species, and we discover general characters which nicely separate them. Further researches presently reveal to us certain forms, including perhaps

several species, which, while agreeing with one group in most of the characters, persistently differ from it in some one feature, and perhaps in this feature they agree with the other group. The question then arises, what is to be done in cases where there are aberrant forms, departing from one type in the direction of another, and blending the characters of the two? Are we to say that our groupings are worthless, and the two must be thrown into one? This produces confusion, and stands in the way of systematic study; and besides we will then probably be no nearer the truth, for we shall doubtless find a similar relation between the group thus formed and some other, which will demand a similar consolidation. On the other hand, shall we stand by the distinctions we have discovered, and range our transitional or aberrant forms into subgroups by themselves, and designate them by proper appellations? We are clearly of the opinion that the latter, judiciously pursued, is the true course, both with regard to convenience of study, and to facilitate the discovery of a natural classification. Without entering into any discussion of the value of these or any other groups as expressions of actual divisions in nature, we propose to adopt this method of treatment, and to recognize subgenera or subgroups of whatever dignity, as the facts may seem to warrant. In so doing we find it decidedly preferable to give each group a name by itself, and consider it as standing alone in its proper rank, and not to name it parenthetically as a mere adjunct to the parent group. If we err on the side of too narrow distinctions, this will only lead to renewed researches and ultimately to the truth.

tinctions which we regard as important in the separation of families and genera. On a former page we have alluded to the dome, which we believe affords excellent characters for separation into families. The general plan upon which it is constructed, whether rigid or flexible, composed of movable or immovable plates; with large oral plates, or covered with numerous small pieces; whether provided with a ventral sac; the location of the anus; all of these in our opinion form good family distinctions. Next to the vault must be considered the general construction of the calyx; the elements of which it consists; whether it has a subbasal zone; the presence or absence of interradianals as a rule; whether the animal was pedunculate or free floating; and last but not least, the structure and position of the respiratory organs.

Among the best *generic* characters in these Crinoids, we find the following: The general form of the body; the distribution and arrangement of the different plates, both in the vault and in the calyx, particularly the plates of the anal area and their proportions; the form and position of the apical dome plates, the position of the anus and whether consisting of a proboscis or simple opening; the form of the column, the shape and proportional size of its central passage; the construction of the arms and pinnule.

The arms and pinnule of the Palaeocrinoidea have not received the attention which they deserve, at least not as to their generic importance. A careful study of these organs, as they occur in different genera, has convinced us, that not only the arms, but also the pinnule, in their variation, in their presence or absence, afford generic characters. Only of late years has attention been drawn to the ambulacral groove of the arm, when it was shown from actual observation that in some genera the furrow is covered by small-plates alternately arranged. Meek and Worthen describe the arms of *Symbathocrinus* as being covered by two rows of single plates, arranged in alternation, and a similar structure has been discovered to exist in the arms of *Cratuloocrinus* and *Enalocrinus*. In *Cupressocrinus*, according to Schultze, the furrow is braced over like a roof. In *Cyathocrinus loricatus*, according to Wachsmuth, and apparently in *Gissocrinus*, Angelin, the furrow is covered by two rows of two successive plates, the plates of one row alternating with those of the other. In *Cyathocrinus longimanus*, Angl. (Iconogr Crin. Pl. 26, Figs. 4, 5), there are in place of only two, a series of five successive plates from each side,

alternately arranged. The plates of each side taper toward the end and infold over the furrow, covering it as perfectly, and in the same manner as in the two former cases. Angelin gives no description, but in his table of contents, he calls the successive plates from each side "pinnulæ."

It is easily seen that the covering to which we refer in the above-mentioned genera, is constructed upon exactly the same principle. It makes but little difference whether there are two single plates or two rows of plates alternating with each other, and it seems evident to us that if in one case they represent pinnulæ, we may well consider them to be the same in the other. It is here important to note that in those genera in which the ambulacral groove is thus covered, no regular pinnules have ever been observed, and moreover the construction is such that no additional pinnulæ could have existed; while on the other hand no covering has ever been discovered in forms with true pinnulæ. From our observations we are of opinion that the pinnulæ generally in the Palæocrinoid served partly as a cover or protection for the furrow. In a specimen of *Graphiocrinus tortuosus*, Hall, in our collection, the pinnulæ cover the furrow so perfectly that we were for some time led to consider them as a solid integument composed of regular spiniferous plates. With a good magnifier, however, we clearly detected the joints of the pinnulæ, which are here so placed that the little spines with which their sides are provided stand up erect. In the *Actinocrinidæ* and *Platycrinidæ* the pinnulæ are long, comparatively slender, and so closely arranged side by side that it appears as if they were connected laterally, which we think it is

TERMINOLOGY, ETC.

There is considerable confusion in the literature of Crinoids—even among contemporaneous writers—as to the terms employed to designate the different parts of the animal. It is to be regretted that there is not some means of establishing uniformity in this respect, as this would no doubt promote better results in investigation. We believe it to be especially desirable, and for the interest of science, that there should be a better understanding on this subject between Zoologists and Paleontologists, so that the same terms may be used, so far as possible, for similar parts in both fossil and living forms. We will not assume to say how this should be brought about, but would be glad to see it undertaken by those of more experience and authority in both fields.

To avoid misunderstanding of our work we give herewith a list of the principal terms employed, with the definitions as understood and used by us. We do not seek so much to introduce new terms as to select the best—in our judgment—of those already known to our branch of science, and then to use them consistently.

Explanation of Terms.

Root = extremity of column, where attached.

Cyrrhi = radicular appendages, springing from the periphery of column joints, or in *Comatula* from the centro-dorsal plate

Column or stem = jointed cylindrical structure below the body.

Body = the frame of the animal, excluding column and arms.

Test = the calcareous shell inclosing the internal organs.

Calyx = the dorsal cup, or the test of the *abactinal* or dorsal side up to the arms — aboral side.

Vault, dome, summit = the test above the arms; the plated covering on the ventral side = *oral side* — *actinal side*.

Ventral sac = vertical extension of the vault in its posterior area, closed at the extremity.

Anal tube or proboscis = posterior vertical elongation of the vault, with anal opening at its extremity. The term "proboscis" is so generally used that we feel compelled to retain it, although there is a serious objection to its use. The word implies that it is an oral organ used for feeding, which is, beyond the slightest doubt, directly contrary to the fact.

Posterior side = the anal side of the body.

Anterior side = the side opposite the anal area.

Right or left = viewed from the posterior side.

Rays = the whole collective succession of plates from the first radial up.

Free rays = radial extensions of the body unconnected by inter-radial plates.

Arms = radial extensions or branches from the body with a furrow on the ventral side.

Pinnules = small, jointed, solid appendages, alternately arranged along the arms.

Tentacles = soft prehensile organs along the ambulacral furrow of the arms and pinnules.

Ambulacral furrow = groove on the ventral side of the arms and pinnules, containing ambulacral canal and food passages.

Proximal plates = those next to the column.

Underbasals = the second ring of plates below the radials, heretofore called "basals" = pelvis of European authors.

Basals = the first ring of plates below the radials, interradians by disposed, equivalent to "subradials" and "parabasals," both of which terms are discontinued by us.

Radials = all the plates of the body above the basals, radially situated.

Primary radials = those in the rays below the first bifurcation.

Secondary radials = those between the first and second bifurcation.

Tertiary radials = those between the second and third bifurcation. 300

interary plates = plates between the divisions of the rays = intersupraradials of Hall and other authors.

interbrachials = plates between the arm openings of each ray.

This term is not strictly correct, when taken in connection with our definition of "brachials," but it has been long used in this sense, and as no confusion is likely to arise, we think it best to retain it.

anals :- the series of interradial plates which support the anal opening or tube.

apical dome plates =: the system of plates in the vault which occupy a position analogous to that of the apical plates of the calyx. They consist: 1, of a central plate at the apex of the dome; 2, of five large plates (there are generally four large and two small ones, the two latter equivalent to one, being separated by the anal area), arranged around the apex, interradially disposed, and corresponding to the first radials; 3, of five radial dome plates, alternating with the last, and corresponding to the first radials. Wachsmuth, Amer. Journ. Sci., Sept. 1877, p. 187, called the first seven of these plates "apical plates." This must be changed to avoid confusion, as the genitals and oculars of Echini are designated by the same term. We now apply the term "apical dome plates" to the whole system of principal vault pieces. These plates, which have no representation in the structure of the Stomatocrinoidea nor Echini, exist in a greatly reduced form in the Blastoids, but are specially characteristic of the Actinoermidae, Platycrinidae, etc. The single plate at the apex we propose to call the *central dome plate*; the first ring of interradials surrounding it, the *proximal dome plates*, and the next ring radially situated, the *radial dome plates*.


rad plates = large interradial plates, covering in form of a pyramid the oral side of the Pentacrinoid larva (Wyville Thomson and Carpenter) — consolidating plates in *Cyathocrinus* (Wachsmuth) — deltoid pieces in Blastoides. The term "consolidating plates" is discontinued.

hydrospires — certain organic structures in connection with the inner walls of the test, composed of parallel tubes or folded sacs, probably in connection with the water system.

respiratory pores or orifices — openings through the test, in connection with the hydrospires, apparently for the introduction of water for respiratory purposes.

In the discussion of the different genera we shall give with each a full list of the species which belong to it, in *our opinion*, independent of the opinion of others, and this will cause many changes in the reference of species. It cannot be expected that these lists will be free from mistakes, though we have studied each species with great care, the majority of them from the specimens, and besides our own extensive collections, one of us had occasion a few years ago to examine the original collections of De Koninck and Schultze, now in the Museum of Comparative Zoology at Cambridge. Nor can it be expected that in a general work on Crinoids like this, we shall give a full list of synonyms, and we have not attempted to do so. This can only be thoroughly done by the collector who has given his attention for years to the fossils of his own locality, and is able to identify them from the least fragment. We shall give the synonyms of the subcarboniferous Crinoids of the Mississippi Valley which we have made our special study, and we hope that investigators will do the same for other localities and formations. We shall feel under special obligations to any of our scientific friends for any information they may be able to furnish us, either in the way of specimens or observations which may contribute to a more thorough understanding and truthful presentation of the subject. We particularly desire this, as we intend to embody the results of all our investigations in this field in a future work to be issued with ample illustrations.

We take this opportunity to tender our thanks to Prof. Agassiz, of Cambridge; Prof. A. H. Worthen, of Illinois; Prof. S. H. Coleman, of Iowa City; Prof. A. G. Webster, of Cincinnati; and



PALÆOCRINOIDEA.

A SUBORDER OF THE CRINOIDEA.

Body, as compared with recent Crinoids, larger; arms shorter; test stronger. The latter is arranged on various plans, but is always composed of solid plates of which the interradians, in contrast to the *Stomatocrinoidea*, constitute important elements. Plates of the aboral or dorsal side forming a cup, closed on the ventral or oral side by a more or less solid integument, without external food grooves or oral aperture.

The food conveyed through openings at the base of the arms into the body, and carried to the oral centre by means of internal or subtegmenal passages. Anus either in form of a plated tube or a simple opening, subcentral or lateral.

The introduction of water for respiratory purposes seems to have been effected through small openings or pores which penetrate the test. These openings, which in some groups were located in the oral, in others in the aboral regions, seem to have been connected with peculiar organs within the body, closely resembling the so-called hydrospires of Cystideans and Blastoids.

The Paleocrinoids, with but few exceptions, were pedunculate, attached during lifetime. Flourishing abundantly in the Silurian seas, they reach their climax in the Subcarboniferous, as well in variety of form as in number of individuals, and they disappear almost entirely during the Carboniferous, few forms, if any, surviving as late as Mesozoic times.

FAMILY I.—*ICHTHYOCRINIDÆ*.

(Diagram Pl. 15, Fig. 1.)

General form of the body including arms, globose to pyriform. Column strong, perforation of medium size, generally pentangular.

Underbasals three, of unequal size; always small, often rudimentary and not visible externally, being hidden by the column. Basals five, moderately small, sometimes scarcely appearing beyond the column (in *Calpuocrinus* probably absent or imperfectly developed). Primary radials, three to five by five, almost equal in form and size. Radials of each order smaller by half than those of the preceding, and of uniform size. Arms bifurcating.

strong, tapering upward, the tips infolding; composed of single joints. Pinnulae unknown. In most of the genera, the arms lie side by side touching laterally, so as to form with the calyx an apparently compact wall. Radial and arm plates frequently have undulating sutures or additional patelloid plates. The radials up to the second or even the third order form a part of the body, being connected laterally either by a sort of squamous integument, composed of very minute, irregular plates, or by distinct inter-radial and axillary plates, the former varying in number from one to thirty or more, the anal area containing frequently a few additional plates. Anus unknown, except in *Taxocrinus* and *Onychocrinus*, which have a small lateral tube. Ventral disc rarely preserved; composed of a more or less soft or scaly integument, yielding to motion in the body and arms.

This family might very appropriately be called the *Articulates* of the Paleozoic Crinoids, being especially distinguished in most of its species by a peculiarity of structure which prevails throughout the rays and arms. The plates have rather shallow excavations on their outer upper margins, corresponding to projections on the lower edge of the succeeding plates, which sometimes take the form of superficial patelloid plates, independently articulated, and sometimes anchylosed with the margin of the plate above. This feature produces what seems to be an articulate structure in the whole skeleton, and indicates that the body as well as the arms was somewhat flexible. The interrarial areas are sometimes four and depressed and in other cases distended, showing that there has been some expansion or contraction of the body walls due to

In *Onychocrinus*, the genus which evidently possessed the greatest expansive power, the radial areas being frequently found spread out horizontally, there are toward the inner or ventral side of the rays rather large plates, to which smaller ones are joined, which connect with the interrarial series. They decrease in size and thickness inwardly, and connect with the dome plates. In a specimen of *Onychocrinus exsculptus*, Lyon, and another of *O. diversus*, Hall, we found the median portion of the vault preserved, the plates being irregularly arranged, rather large and thin. This important observation goes far toward proving that the *Ichthyocrinidæ* had no external oral aperture, for if any of the family were likely to have it, it would be *Onychocrinus*.

The *Ichthyocrinidæ* are nearest related to the *Cyathocrinidæ*, from which they differ in having several orders of radials included within the body; in the articulate structure of the radial portions; in the presence of interrarial plates within the regions of the calyx, and in the pliant vault.

The separation of the genera in this family has always been attended with difficulty, and it cannot be denied that several of them shade into one another in a most perplexing manner. They are very closely related, and yet there is a *habitus*, peculiar to typical forms of each genus, which is not easily described, but which is readily perceived when large collections are brought together, and which Paleontologists discerned at an early day. It is the gradations—the *transition forms*—which make trouble, and have given rise to continual modifications of the generic formulæ in hope of reconciling them with new discoveries. While we cannot expect that the divisions we have made are wholly free from errors, yet we find when we arrange the different species according to the generic characters herein given, that the groupings are more nearly conformable to the recognized *habitus* of the fossils than any we have been able to make heretofore, and we are encouraged to hope that we may have approximated more closely to the natural divisions.

The *Ichthyocrinidæ* range from the Lower Silurian to the close of the Subcarboniferous.

We recognize the following genera:—

1. *ICHTHYOCRINUS* Conrad.

1836. *Euryocrinus*. Phill. Geology of Yorksh., p. 205.
 1842. *Ichthyocrinus*, Conrad. Journ. Acad. Nat. Sci. Philad., vol. viii. p. 279.
 1851. *Ichthyocrinus*, d'Orbigny. Cours. elem. Pal. ii. p. 144.
 1851. *Ichthyocrinus*, Hall. Geol. Rep. N. York, vol. ii. p. 195.
 1878. *Ichthyocrinus*, Angelin. Iconogr. Crinoid., p. 18.
 1878. *Ichthyocrinus*, Wachs. & Springer. Proceed. Acad. Nat. Sci. Philad., p. 252.

A. Typical form.

General form of body, including arms, ovoid to pyriform, with almost equilateral pentamerous symmetry. Calyx bowl or cup-shaped. Underbasals three, rudimentary, of unequal size, sometimes seen only within the calyx. Basals five, very small, their upper angles acute. Radial plates of adjacent rays alternately arranged. Primary radials three to four by five, wide and short, height about equal, but increasing in width rapidly upward, the plates being wider at their upper margins than at the lower. Secondary and tertiary radials similar in form to the primary, quadrangular in general outline, though really pentangular and hexangular, those of the same order of equal height, and half the width of those of the next order. Arms twenty to sixty or more, accumbent, infolding at the tips, and forming with the calyx an apparently solid structure. They are composed of single joints which are heavy, wider than high, quadrangular, usually with widening sutures. Arm furrows shallow, tripartite. Pinnulae unknown. Interradial and anal plates generally absent or undeveloped on the outside, *I. nobilis*, Wachs. & Spr. alone, to our knowledge, possessing both; they are longitudinally arranged, but the anal side cannot be distinguished. Vault unknown. Column con-

mentions a single anal plate, which is not to be found in his figure. The presence of anal, interr radial, and even axillary plates in *I. nobilis* which, as far as known, is the latest representative of the genus, is very instructive, as it shows the approach to *Forbesiocrinus*. In young specimens these plates are undeveloped externally, but are plainly visible on the inner surface of the calyx.

Phillips, in 1836 (Geology of Yorksh., p. 205), described the genus *Euryocrinus*, which is possibly the same as *Ichthyocrinus*, and might be entitled to priority, but his description and figures are so unintelligible that this would be injustice to Conrad. Phillips' generic description reads as follows: "Pelvis opening pentagonal, arrangement of plates like *Eocrinus*, internal cavity very large." Not much better are his figures, since they induced Bronn to consider *Euryocrinus* as a synonym of *Actinocrinus*.

Geological and Geographical distribution.—*Ichthyocrinus* is found first in the Upper Silurian, where it is represented in Europe by 3 species, in North America by 5. None have been observed in rocks of Devonian age. In the Subcarboniferous 3 species have been discovered in America, none in Europe (unless we count *Euryocrinus concavus* Phillips).

We regard the following species as belonging to this genus:—

- 1-55 *Ichthyocrinus Burlingtonensis* Hall. Geol. Rep. Iowa, vol. i, pl. ii, p. 57.
Lower Burling. limest. Burlington.
- 1-56 *Ichthyocrinus Clintonensis* Hall. Geol. Rep. N. Y., vol. ii, p. 181, pl. 41,
figs. 6 a, b, c. Niagara gr. New York State.
- 1-57 *Ichthyocrinus Corbis* Winchell & Marey. Memoirs Bost. Soc. Nat. Hist.,
vol. i, No. 1, p. 89. Niagara gr. Chicago, Ill.

Regarded by Hall as syn. of *Ichthyocr. subangularis*.

- 1-72 *Ichthyocrinus Gotlandicus* Wachs. & Spr. *Ichthyocr. lævis* Angl. not
Conrad. Iconogr. Crinoid., p. 13, pl. 9, figs. 87 a-c, and pl. 22, figs. 20,
21. Upper Silur. Gotland, Swed.

The Swedish specimens, which by Angelin were identified as *I. lævis*, Conrad, are very distinct from the New York species which Conrad described. The European form is pear-shaped instead of ovoid, the plates ornamented, but without any surface angularity, and with nearly straight sutures; while the New York specimens have plates with smooth but angular surface, and very distinct waving sutures. We therefore suggest their separation, and propose to call the Swedish form *I. Gotlandicus*.

- 1-73 *Ichthyocrinus intermedius* Angelin. Iconogr. Crin., p. 13, pl. 17, fig. 7.
Upper Silur. Gotland, Swed.

1842. *Ichthyocrinus levis* Conrad (not Angl.) Type for the genus. Journ. Acad. Nat. Sci. Philad., vol. xlii. p. 279, pl. 15, fig. 16; also 1852, Hall, Pal. N. York, vol. ii. p. 195, pl. 43, fig. 2. Niagara gr. Lockport, N. Y.
1878. *Ichthyocrinus nobilis* Wach. & Spr. Proceed. Acad. Nat. Sci. Philad., p. 254. Upper Burl. and Keokuk transition bed. Burlington, Iowa.
1839. *Ichthyocrinus pyriformis* Phillips. (Cyathocr. pyriformis.) Sil. System, p. 672, pl. 17, fig. 6; also Iconogr. Crin., p. 13, pl. 17, fig. 6; and pl. 22, fig. 22. Upper Silur. England and Sweden.
- *1852. *Ichthyocrinus simplex* Hall. (Lecanocr. simplex.) Geol. Rep. N. York, vol. ii. p. 202, pl. 44, figs. 2 a, b, c. Niagara gr. Lockport, N. Y.

Hall's figure evidently represents a young *Ichthyocrinus*, and not a young *Lecanocrinus* as he supposed.

1862. *Ichthyocrinus subangularis* Hall. Trans. Albas. Inst., Article xii., p. 7. Niagara gr. Waldron, Ind.
1850. *Ichthyocrinus tiariformis* Troost. (Cyathocr. tiariformis. Troost's Catal., and Geol. Rep. Iowa, vol. i., part ii., p. 558. Subcarbon. Tennessee.

B. Subgenus HOMALOCRINUS Angelin.

1878. Iconogr. Crinoid., p. 11.

We consider *Homalocrinus* not sufficiently distinct from *Ichthyocrinus* to rank it as a full genus, but propose the name for a division under *Ichthyocrinus*. The following is a translation of Angelin's generic description: "Body including arms ovoid. Basals three, small. Parabasals five, triangular, placed between the sides of the primary radials. Primary radials transverse, and in the form of a half moon. Interradials three, the lower one heptagonal and large, with two small ones above. Anals three, subequal. Rays several times dichotomizing." Angelin described *Ichthyocrinus* without interr radials or anals, and it seems that upon this feature mainly he separates *Homalocrinus*. We find, however, in the only known species the anal area slightly different from the interr radial and the primary radials. instead of increasing from the

ric description was made from a single specimen, and several respects defective. *Cleiocrinus* has, according to Billings, five basals alternating with the radials, and forming a belt around the column. Such a structure has never been found in any Crinoid. In the typical specimen, the comparatively large column conceals from view the lower part of the calyx large enough to accommodate one or two series of elements. Analogy suggests that this may have been the case. The elements which Billings found alternating with the primary radials which he called basals, are certainly interradians; and the specimen in every visible character closely resembles *C. regius* and allied forms, we have good reason to suppose that those forms, possessed five small basals and three interradians, both hidden by the column. The latter were probably minute and rudimentary, since the specimen is from the Trenton, where it is almost the only representative of the genus. This alone induces us to try to define generic characters from the imperfect specimen. Notwithstanding, therefore, that the elements are problematic, we propose until some better specimen is found, the following:—

Generic description.—Calyx obconical or pyriform, with five orders of elements. Underbasals probably three, minute or rudimentary. Basals probably five, very small and hidden by the primary radials three by five, increasing in width upwards, and several superior orders of radials all dichotomizing and interlocking laterally with those of adjoining rays. Interradians, so far as known, one. Anals four to five, longitudinal. *C. regius* has six orders of radials, the number of elements doubling with each bifurcation, which gives in the sixth order 64 elements to each ray or 320 to the individual. Whether the appendages which are seen at the top of the specimen cannot be determined from the figure.

Known species is:

C. regius Billings. Geol. Rep. Canada, p. 276; and 1859, Decade 53, pl. 5, figs. 1 a-g. Trenton limest. Ottawa, Can.

Billings refers to this genus two other species, *C. grandis* and *C. minor*, which he described from mere fragments of the calyx which we cannot recognize. The fragments may belong to *C. regius*, or to almost any other genus.

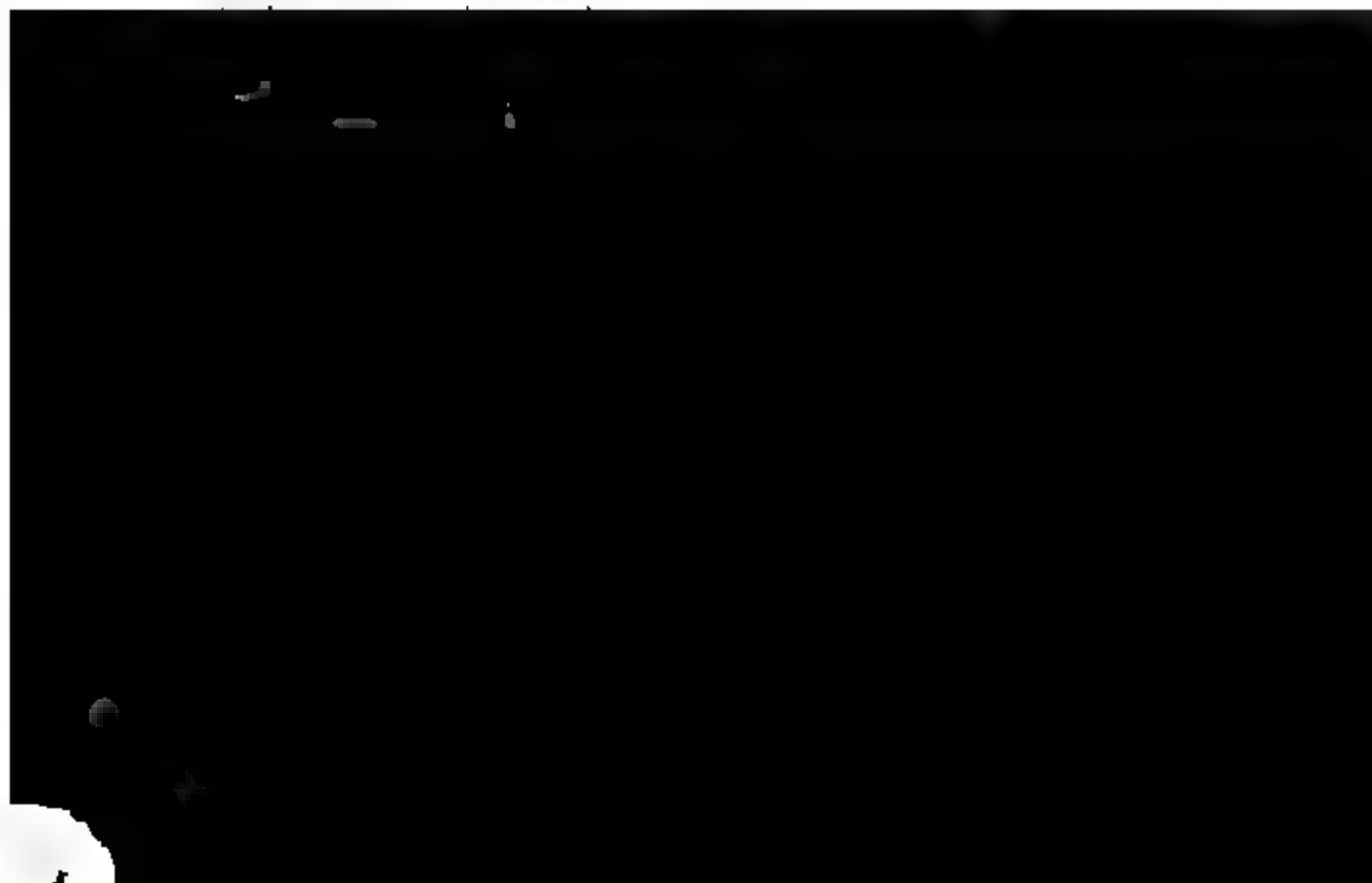
3. *ANISOCRINUS* Angelin

1878. Iconogr. Crinoid., p. 13.

General form of body, including arms, ellipsoid. Calyx bowl-shaped; figure bilateral.

Underbasals three, hidden by the column. Basals of medium size, dissimilar in form. Primary radials three to five, the first widest, almost as large as second and third together; the second smallest of all. Secondary radials two, gradually increasing in size upward, the bifurcating plate almost as wide as the third primary radial. Arms apparently free above the secondary radials, accumbent as in *Ichthyocrinus*, and composed of transverse joints. Interradials one (sometimes with a small triangular piece above), very large, resting with the lower angle against the short upper lateral sides of the first radials, forming with them a compact wall. Anals two, very large, the upper one the largest plate in the body; the acute angle of the lower leaning against the basals, with the lower lateral sides resting against the adjoining subradials, and its upper lateral sides against the large first radials. The second anal plate rests upon the upper truncated side of the lower one, being in line with the interrarial plates, and reaches like them up to the top of the secondary radials.

The arrangement and size of the interrarial and anal plates are the characteristic features of this genus. Angelin's descriptions are rather indistinct on this point, and in order to have it properly understood, we give almost a specific description, which will probably have to be modified when more species are discovered.



4. **CALPIOCRINUS** Angelin.

1878. *Calpiocrinus* Angl. Iconogr. Crinoid., p. 12.

1878. *Clidochirus* Angl. (syn.). Iconogr. Crinoid., p. 12.

General form of body, with the arms closed, ovoid or pyriform. Calyx bowl-shaped, composed apparently of only one ring of plates below the radials; figure bilateral. This ring consists of three plates, one of them small, the two larger ones equal, forming together a pentagonal disc. Primary radials three by five, three times wider than high, differing in size and form; the first one lunate, the second quadrangular, the third and largest pentagonal. Secondary radials three to four, about equal in size, except those in the posterior rays whose lateral margins retreat to give space for the large anal plates. The upper secondary radials support the arms, some of which bifurcate, while others remain free. Arms similar to those of *Ichthyocrinus*, their sides closely abutting, forming a wall continuous with that of the calyx. Arm joints transverse, quadrangular. Interradials rarely more than one, which is small, wedged in between the second and third radials of adjacent rays. Anals three to five, longitudinally arranged, the lower and smallest which is almost triangular resting upon the basal plates, the upper one extending to the top of the secondary radials. Column slender, round, composed of very thin segments; central perforation small, stellate.

This genus, as described by Angelin, differs from all the rest of the family in having but one ring of plates below the radials, and this consists of three plates, unequal but apparently so proportioned as to be partly radial and partly interrarial in position. The various figures, however, disagree in the latter respect. Such a structure would seem to warrant its separation into a distinct family, but as *Calpiocrinus* agrees in all other characters with the *Ichthyocrinidae*, we feel satisfied that it naturally belongs here. We are inclined to think that in this genus the lower ring of plates is the analogue of the underbasals, and that the true basals, if not absent, are exceedingly rudimentary. We take the small triangular plate which has been called the first anal plate, to be the basal (subradial) on the posterior side which is larger in the whole family, and that the plates on the four other sides are very minute or only visible in the inside.

The presence of but one ring of plates visible below the radials,

the bilateral symmetry of the calyx, and the longitudinal arrangement of the anal plates, are the most prominent characters of the genus.

Angelin, on the same page, describes the genus *Clidochirus* with a single species, which agrees with *Calpocrinus* in every respect, except that it has no interradiial plates, and four instead of three first radials—variations which may be expected even in the same species.

Geological and Geographical Distribution.—Found thus far only in the Upper Silurian of Gotland, where the following species have been discovered:

- 1878. *Calpocrinus fimbriatus* Angelin. Iconogr. Crinoid., p. 12, pl. 29, figs. 77 a, b. Upper Silur. Gotland, Swed.
- 1878. *Calpocrinus heterodactylus* Angelin. Iconogr. Crinoid., p. 12, pl. 3, fig. 10 a; and pl. 26, fig. 8. Upper Silur. Gotland, Swed.
- 1878. *Calpocrinus humilis* Angelin. Iconogr. Crinoid., p. 12, pl. 23, figs. 28 a-c, and pl. 26, fig. 17. Upper Silur. Gotland, Swed.
- 1878. *Calpocrinus ovatus* Angelin. Iconogr. Crinoid., p. 12; pl. 16, figs. 17-19. Upper Silur. Gotland, Swed.
- *1878. *Calpocrinus pyrum* Angelin (*Clidochirus pyrum*). Iconogr. Crinoid., p. 12, pl. 22, fig. 23. Upper Silur. Gotland, Swed.

5 LECANOCRINUS Hall.

- 1852. *Lecanocrinus*, Hall. Geol. Rep., N. Y., vol. ii. p. 199.
- 1867. *Lecanocrinus*, Shultze. Monogr. Echinod. Eifl. Kalkes, p. 40.
- 1878. *Lecanocrinus*, Angelin. Iconogr. Crinoid., p. 12.

A. Typical form.

General form of body and arms subglobose to pyriform. Calyx

the body between the two unequal basals, the adjoining radial, and the other anal plate. The second or upper and larger anal plate is interposed between the primary radials and the upper truncated side of the posterior basal. Column round, composed of rather large joints.

Hall, Schultze, and Angelin mention no interradians in their generic descriptions, but the latter figures a specimen from Gotland, which he refers to *L. macropetalus* Hall. It has one exceedingly large interradial to each area, which occupies a wide space between the rays, opposite all the primary radials, and as high as the top of the second or third secondary radial. No New York specimen of this species has ever been found with such a plate or even a trace of it, and as the two differ besides decidedly in the size of the basals, in the form and proportions of the body, and in other characters, we consider the Swedish form even generically distinct. (See *Anisocrinus Angelini*, W. & Spr.).

Geological and Geographical Distribution.—This genus is represented in the Upper Silurian by 5 species, 4 from America, and 1 from Europe. From the Devonian but a single species is known, and none from the Subcarboniferous.

The following are the known species:—

- 1875 **Lecanocrinus Billingsi** Angelin. Iconogr. Crinoid., p. 12, pl. 22, fig. 2 a. Upper Silur. Gotland, Swed.
- 1882 **Lecanocrinus calyculus** Hall. Geol. Rep., N. Y., vol. ii. p. 203, pl. 46, figs. 3 a, b. Niagara gr. Upper Silur. Lockport, N. Y.
- 1882 **Lecanocrinus macropetalus** Hall (not Angelin) (= **Anisocrinus Angelini**, W. & Spr.). Type of the genus. Geol. Rep., N. Y., Vol. ii. p. 199, pl. 45, figs. 1 a-h. Niagara gr. Lockport, N. Y.
- 1882. **Lecanocrinus ornatus** Hall. Geol. Rep., N. Y., vol. ii. p. 201, pl. 44, figs. 2 a-m. Niagara gr. Lockport, N. Y.
- *1882. **Lecanocrinus pusillus** Hall. (= **Cyathocr. pusillus**.) New Foss. of Niagara gr. p. 6, and 25th Rep., N. Y. State Cab. Nat. Hist., pl. 15, figs. 1-6. Niagara gr. Walhron, Ind.

Winchell and Marcy, Memoirs Bost. Soc. Nat. Hist., p. 10, described a cast from the Niagara limestone of Chicago under the species *Lecanocr. pusillus*, which is probably identical with Hall's *Cyathocrinus pusillus*. The description is not sufficient to decide it fully.

- 1887 **Lecanocrinus Rœmeri** Schultze. Echinod. Eid. Kalk, p. 41, pl. 3, figs. 8 a-g. Devonian. Eifel, Germ.

B. Subgenus *PYCNOSACCUS* Angelin.

1878. Iconogr. Crinoid, p. 18.

The distinction between *Pycnosaccus* and *Lecanocrinus* seems to us scarcely sufficient to warrant a full generic separation. The two agree in all essential features, except that the former, according to description, has two primary radials instead of three, and that the plates of the calyx are ornamented by radiating ridges, such as are frequently found in *Barycrinus*. Even in that genus, the ornamentation is not constant, and at the most is a very unreliable character. In *L. Rœmeri* Schultze, which has entirely smooth plates, we find in two rays only two primary radials as in *Pycnosaccus*. It is very significant that if we consider the first and second radials of *Lecanocrinus* as one plate, we obtain exactly the proportions of the first radial in *Pycnosaccus*, which in our opinion here replaces the first and second radials, while the bifurcating second radial of *Pycnosaccus* actually represents the third radial of *Lecanocrinus*. Form of body, arrangement of the anal plates, and construction and folding of the arms precisely as in *Lecanocrinus*, only that the arm plates are slightly higher.

1878. *Pycnosaccus* (?) *costatus* Angelin. Iconogr. Crinoid, p. 14, pl. 15, fig. 13. Upper Silur. Gotland, Swed.

(This species belongs probably to the *Cyathocrinidae* (?)).

1878. *Pycnosaccus nodulosus* Angelin. Iconogr. Crinoid., p. 14, pl. 15, figs. 12, 14, and pl. 28, fig. 29. Upper Silur. Gotland, Swed.

1840. *Pycnosaccus scrobiculatus* Hisinger. (*Cyathocrinites scrobiculatus*(?)). Leth. Suec. Supplem. II. p. 6, pl. 39, figs. 4 a-c, also 1878, Angelin. Iconogr. Crinoid, p. 14, pl. 15, figs. 10, 11. Upper Silur. Gotland, Swed.

ond radials wedgeform, shorter, but as wide as the first. The third radials support two arms which bifurcate once. The arms are extremely short, composed of very few joints, tapering rapidly upward, infolding, inclined obliquely from left to right, and when closed they fit so neatly one into the other, that it appears as if they formed together with the calyx a continuous body. Arm joints single, slightly cuneate. Interradials none. Anals one, subquadrangular, resting upon the larger basal. Column round, composed of thin joints near the body, increasing in length so rapidly towards its base, that in four inches the joints attain a length of half an inch. Central perforation of medium size.

L. Schultze, in his *Monograph der Echinod. Eifl. Kalk.*, p. 40, pronounces *Mespilocrinus* a synonym of *Lecanocrinus*. In this he is evidently mistaken. *Lecanocrinus* has arms like *Ichthyocrinus*, while those of *Mespilocrinus*, in place of being straight, are turned to the right, and the radial and arm plates are consequently wedgeform instead of rectangular. Schultze's *Lecanocrinus Rormeri*, on which he based the above conclusion, is a most interesting species to show the relations between the two genera. It occurs in the Devonian and zoologically occupies an intermediate position between the Silurian form *Lecanocrinus* and *Mespilocrinus* of the Subcarboniferous. *L. Rormeri* not only has very short arms, but they fold up almost as in *Mespilocrinus*, yet they have rectangular joints and are not deflected. The species has also the unsymmetrical arrangement of the anal area, but the odd plate is here exceedingly small, and has, when combined with the large one, exactly form and proportions of the single anal plate in *Mespilocrinus*, thus approaching and foreshadowing the bilateral form which succeeded in the Subcarboniferous.

Mespilocrinus seems to be strictly a subcarboniferous genus, and only four species are known:—

- 2553 *Mespilocrinus Forbesianus* De Koninck and Lehon. *Recherch. Crin. Belg.*, p. 112, pl. II, figs. 1 a-c. Mountain Limest. England and Belgium.
- 2553 *Mespilocrinus granifer* De Koninck and Lehon. *Recherch. Crinoid. Belg.*, p. 114, pl. II, figs. 6 a-c. Mountain Limest. Visé, Belgium.
- 2559. *Mespilocrinus Konincki* Hall. *Supplem. Geol. Rep. Iowa*, p. 69. Burlington Limest. Burlington, Iowa.
- 2561 *Mespilocrinus scitulus* Hall. *Prelim. Not. New Pal. Crinoids*, p. 9. Burlington Limest. Burlington, Iowa.

7. TAXOCRINUS Phillips.

1836. *Poteroocrinus*, Phillips (in part). Geol. Yorksh., vol. i. (not Miller).
 1841. *Isocrinus*, Phillips. Pal. Foss. Cornw. (not H. von Meyer 1837).
 1842. *Oladoocrinus*, Austin. Ann. & Mag. Nat. Hist., vol. x. (not Agassiz).
 1843. *Taxocrinus*, Phillips. Morris's Cat. Brit. Foss., p. 90.
 1851. *Cyathocrinus*, Roemer. Leth. Geognost. (3te Ausgabe), p. 233 (not Miller).
 1853. *Forbesiocrinus*, de Kon. & Leh. (in part). Recherch. Crinoid. Belg. p. 119.
 1866. *Taxocrinus*, Schultze. Echinod. Elß. Kalkes, p. 33.
 1878. *Taxocrinus*, Angelin. Iconogr. Crinoid., p. 8.
 1878. *Taxocrinus*, sub-genus of *Ichthyocrinus*, Wachsm. & Spr. Proceed. Acad. Nat. Sci. Philad. p. 252.

According to Phillips (Morris's Catal. Brit. Foss.), *Taxocrinus* has "5 basals; 3 radial plates in 5 series; arms dividing upon the third radial and frequently dichotomizing above this point; arms and branches of single series of joints, interbrachial and axillary plates."

This description embraces almost every genus of the *Ichthyocrinidæ*, among them *Forbesiocrinus*.

Johannes Müller, Monatsbericht der Berliner Akademie, March, 1858, was the first who mentioned the presence in *Taxocrinus* of three small pieces within the parabasalia—basals,—similar to those found by Hall in *Ichthyocrinus*, and in species which were supposed to be *Forbesiocrinus*. Müller's discovery was evidently overlooked by Hall, who in 1858 described his *Taxocrinus interscapularis* with five basals and no subradials; and in 1861, and

anal nor interradial plates, while *Forbesocrinus* had both, and sometimes a large number of them.

In 1866, both Meek & Worthen and Schultze wrote on this subject, and arrived independently at the same conclusion. The former, in an elaborate article in the Illinois Geological Report, vol. ii. p. 270, show that the same species may have sometimes no interradials, and again from one to three. They refer to *Tarocrinus* Hall's *Forbesocrinus Thiemei*, which was described as having no interradials, but which has sometimes two, and which we have even found with as many as five regular interradial plates. The one, according to De Koninck, would be *Tarocrinus*, the other *Forbesocrinus*. To amend the generic formula so as to admit species with one or two series of interradials, did not seem to those authors expedient, since the species exhibit such a wide range of variation in this character. Nor do they consider the presence of axillary plates which occur in both groups, nor the small patelliform supplementary pieces of some well-defined species of *Forbesocrinus* a means of distinction, inasmuch as they are not always present in otherwise typical forms of that group; while well-marked species of *Tarocrinus* are described as showing the patelloid plates between the arm joints. Meek and Worthen therefore concluded, until more distinctive characters should be discovered, to place *Forbesocrinus*—embracing species with many interradial and anal plates—as a mere section under *Tarocrinus*.

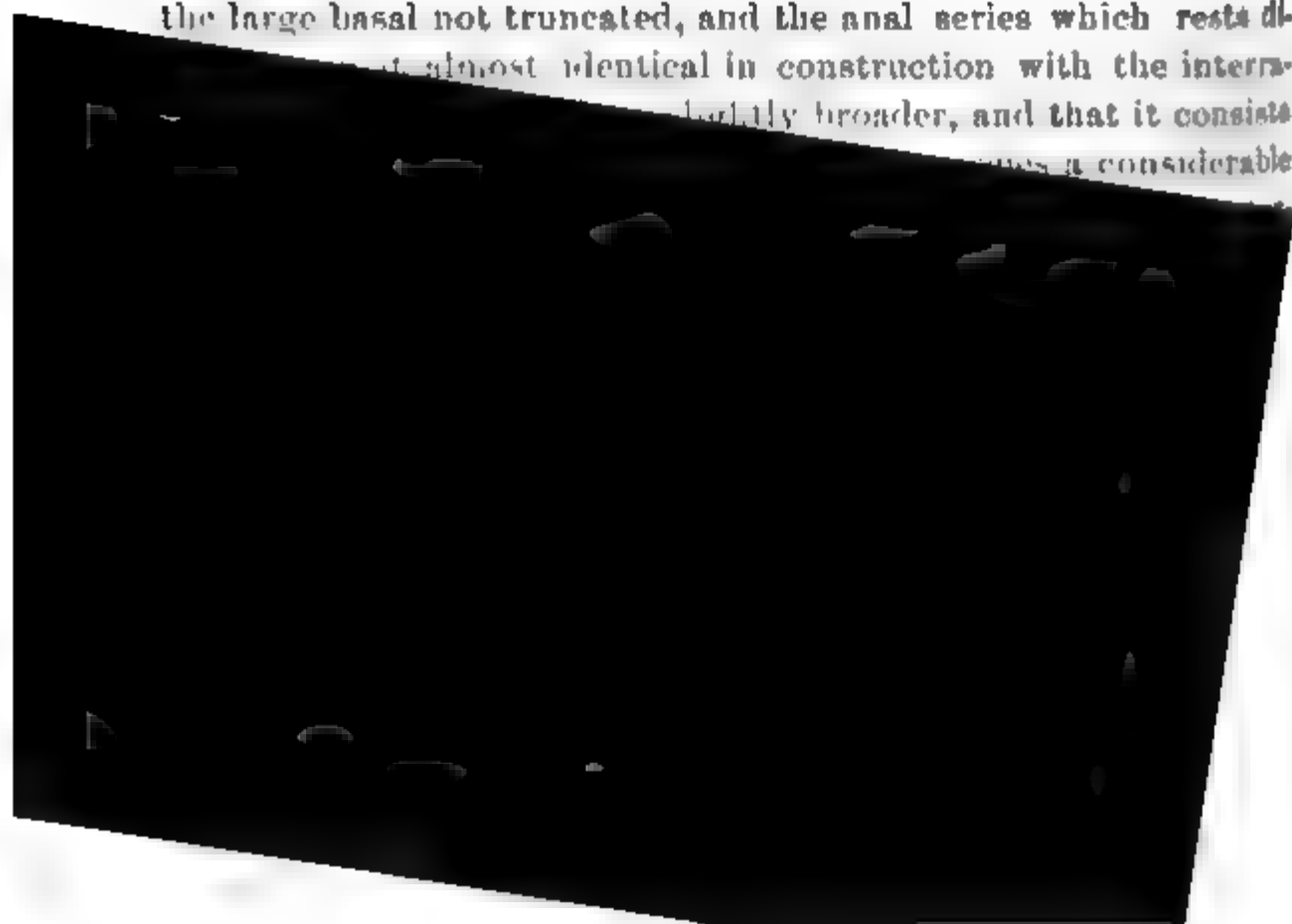
Schultze found in his Devonian species almost every character of *Forbesocrinus* except the small patelloid plates, but whether these were sufficient to distinguish it from *Tarocrinus*, he did not wish to decide, and so he placed the species from the Eifel, in which these plates do not occur, under *Tarocrinus*. He, however, included with this genus species which evidently belong to very distinct genera.

Angelin, in the Iconographia Crinoideorum Sueciae, pp. 8, 9, gives generic descriptions both of *Tarocrinus* and *Forbesocrinus*, and ranges under the two genera several new species. His descriptions only differ, so far as we understand them, in this: that in *Forbesocrinus* the number of primary radials is left an open question, while in *Tarocrinus* the number is fixed at 3 x 5; that the former had one large hexagonal anal plate (he evidently meant, to judge from his figures, "and other smaller ones succeeding"), and a considerable number of interradials, the lower one

much the largest; while *Taxocrinus* has two series of anals and several interradials. The three underbasals are comparatively large in both groups. Angelin's descriptions of both genera are short, and give us but little additional information regarding their relations; on the contrary they rather increase the difficulty, none of his species of *Taxocrinus* or *Forbesiocrinus* are true representatives of either, thus raising the question whether the Swedish species ought not to be considered as types of new genera or at least be separated subgenerically. We prefer the latter course, and propose *Gnorimocrinus* for the former, and *Lithocrinus* for the latter.

Phillips in proposing the genus *Taxocrinus* included in it the following species, in the order in which we give them, viz., *Poteriocrinus Egertoni* Phill. 2. *Cyathocrinus tuberculatus* Miller 3. *Cyathocrinus macrodactylus*; and 4. *Cyathocrinus nobilis* Phill. The first of these, a subcarboniferous species, with no but few interradials, must be considered, according to the most generally accepted rules of naturalists, the type of the genus. The second and third species have but one or two interradials, *T. tuberculatus*, according to Pictet's figure, one or two anals resting on the upper truncated side of the large basal. The fourth species was Koninck & Lehon's type of their genus *Forbesiocrinus*.

Now comparing the anal arrangement of the latter—or rather of *Forbesiocrinus Agassizi* Hall, which undoubtedly belongs to the same group, and in which these parts are better known—we find the large basal not truncated, and the anal series which rests almost identical in construction with the interradials, but broader, and that it consists of a considerable



we find the first anal either directly upon the truncated basal as in *Tarocrinus tuberculatus*, or sometimes, in species in which the first radials join laterally, the first anal is placed opposite the second and third or even between the third radials, as in *Tarocrinus Thiemei*, but in either case, with the exception of the Swedish specimens, the anal plate has a truncated upper side, and is succeeded by from two to six similar, narrow, quadrangular plates, longitudinally arranged. The plates diminish in size upwards, and form the dorsal side of a short and slender lateral proboscis, whose ventral parts, as well as the wall supporting them, have never been found preserved, and evidently consisted of more fragile material.

Returning to the interradial series we find specimens with apparently none to three or more interradial plates, with variation even in the individual, and some with as many as nine interradials, though in no instance extending up higher than to the top of the third primary radials, above which the rays are almost always free in the fossil. This, however, was not the case in the animal. Schultze found in his *T. juglandiformis*, within the open spaces between the rays, as well as between the first divisions of the rays, a large number of very minute, uneven and twisted pieces, which evidently took the place of the larger interradial plates in all cases where those did not exist. Similar pieces were figured by Angelin in the Swedish species, and they probably were present in all *Tarocrini*.

In some well-preserved specimens of *Tarocr.* (*Forbesocr.*) *multibrachiatus* Lyon & Cass, from Crawfordville, Indiana, and in a *Tarocrinus ramulosus*, Hall, from Burlington, Iowa, we have had an opportunity to examine this structure. Both species have a comparatively large number of interradials, the former from three to nine, arranged in from two to four series, the other six to seven in three series. These plates are quite prominent and differ but slightly in size. The little plates in question, or the plated integument as we should rather call it—the plates seem to be imbricated—is attached to the upper series of interradials, and fills the rather large interradial space up to the top of the secondary radials, inclosing the axillary spaces between the series of the latter up to the first arm joints, and evidently covering the entire oral side of the body. On looking at the anterior side of these specimens, the construction seems almost identical with

that of *Forbesiocrinus*, except that the upper part of the interradial area is less substantial and compact; but their posterior aspect exhibits in *Taxocrinus* a small lateral proboscis, while in *Forbesiocrinus* the space is filled with heavy plates, in the latter an almost pentamerous symmetry, in *Taxocrinus* (except in the Swedish species), a distinct bilateral one. This we consider the best distinction between the two genera. (Compare Diagram, Pl. 15, Fig. 2.)

An examination of a very large series of well-preserved specimens of the two genera has led us to this conclusion, and to a modification, to this extent, of the opinion intimated by us heretofore (Proceed. Phila. Acad. Nat. Sci., 1878, p. 254), that there is no distinction between these genera. We find that in practice we can separate them quite satisfactorily by the characters herein indicated, and, accordingly, we propose the following revised generic diagnosis:—

A. Typical form.

Body, including arms, rather short, depressed; calyx cup- or bowl-shaped, with bilateral symmetry. Underbasals three, sometimes very small, unequal in size, the two larger ones pentangular, the smaller quadrangular. Basals five, four of them equal and with acute upper angles, the fifth larger, generally with truncated upper sides. Primary radials three—rarely four—by five, of nearly equal size, wider than high, quadrangular in outline, except the upper one which is pentangular. Secondary radials varying in number from three to six—the former most prevalent—slightly smaller than the primary radials, and resembling them in general

radials. Anal plates resting upon the truncated upper side of the larger basal, or sometimes placed independently in line with second and third radials. They consist of a series of from two to five narrow quadrangular plates, longitudinally arranged, the upper ones forming the dorsal side of a small lateral proboscis. Column comparatively large, rapidly tapering, composed near the body of thin joints, which gradually increase in thickness as they diminish in diameter. Central perforation of medium size, pentangular as far as observed.

Geological and Geographical Distribution.—*Taxocrinus*, so far as known, appears first in Europe, where it is represented in the Upper Silurian by 2 species, in the Devonian by 3, and in the Subcarboniferous by 2. In the United States and Canada (if we exclude *Lecanocr. (?) elegans*, from the Trenton group), it is first found in the Devonian, from which 4 species are known, and from the Subcarboniferous 13 are described.

We include in the typical form of the genus the following species:—

- 1856 *Taxocrinus affinis* Muller. *Neue Echinod. d. Eifel*, p. 241, pl. 1, figs. 1, 2; also *Schultze*, 1866, *Echinod. Eifel Kalks.*, p. 34, pl. 4, fig. 2. Devonian. Eifel, Germ.
- 1843 *Taxocr. brevidactylus* Aust. (*Cladocrinus brevidactylus*). *Ann. and Mag. Nat. Hist.*, vol. ii., p. 198; also *Rec. and Foss. Crin.*, p. 89, pl. 11, fig. 4. Subcarbon., Ireland.
- 1867 *Taxocr. communis* Hall. (*Forbesioc. communis*). 17th Regts. Report, N. Y. State Cab., p. 55; also 1877, *Paleont. Rep. Ohio*, Vol. ii., p. 169, pl. 12, figs. 3-5. Waverly group. Richfield, O.
- 1876 *Taxocr. Egertoni* Phillips. (*Poterioc. Egertoni*). *Geol. Yorksh.*, ii., pl. 3, fig. 39. Subcarbon. Yorkshire, Eng.
- 1858 *Taxocrinus Giddingei* Hall. (*Forbesiocrinus Giddingei*). *Geol. Rep. Iowa*, vol. i., pt. ii., p. 653, pl. 17, figs. 2, 4. Keokukimest. Illinois, Iowa.
- 1865 *Taxocr. gracilis* Meek and Worthen. *Proceed. Acad. Nat. Sci. Phila.*, p. 142; also *Geol. Rep. Illinois*, vol. iii., p. 421, pl. 13, fig. 3. Hamilton gr. Jackson Co., Ill. and *Taxocr. gracilis* *Schultze*. *Rhopalocrinus gracilis*, Wachsm. and Spr.
- 1867 *Taxocr. incurvus* Trautschold. (*Forbesioc. incurvus*). *Crin. des jungeren Bergk.* Moskau, p. 31; also *Kalkbr. von Mjatschkowa*, p. 126, pl. 14, fig. 11, and pl. 15, fig. 3. Subcarb., near Moscow, Russ.
- 1858 *Taxocr. interscapularis* Hall. *Geol. Rep., Iowa*, vol. i., pt. ii., p. 482, pl. 1, fig. 3. Hamilton gr. New Buffalo, Iowa.
- 1867 *Taxocrinus juglandiformis* Schultze. *Echinod. Eifel Kalks.*, p. 35, pl. 4, fig. 4. Devonian. Eifel, Germ.

- *1861. *Taxocr. juvenis* Hall (Forbesocr. *juvenis*), Bost. Journ. Nat. Hist., vol. vii. No. 2, p. 319. Lower Burl. limest., Burlington. —
- *1863. *Taxocr. Kelloggi* Hall. (Forbesocr. *Kelloggi*), 17th Regt. Rep. N. Y. State Cab., p. 56; also Geol. Rep., Ohio, Paleont., vol. ii. p. 171, pl. 12, fig. 1. Waverly gr., Subcarb. Richfield, Ohio. — 3.
- *1862. *Taxocr. lobatus* Hall (Forbesocr. *lobatus*), 15th Regt. Rep. N. Y. State Cab., p. 124. Hamilton gr. Ontario Co., N. Y. — 1.
- *1863. *Taxocr. lobatus* var. *tardus* Hall. (Forbesocr. *lobatus* var. *tardus*), 17th Regt's Rep. N. Y. State Cab., p. 56; also Geol. Rep. Ohio Paleont., vol. ii. p. 171, pl. 12, fig. 1. Waverly gr. Richfield, Ohio. — 2.
1841. *Taxocr. macrodactylus*, Phillips. (Cyathocr. *macrodactylus*). Paleoz. Foss. Corniv., p. 29, pl. 15, fig. 41. Subcarbon. England. — 2.
- *1858. *Taxocrinus Meeki* Hall. (Forbesocr. *Meeki*), Geol. Rep. Iowa, vol. i., pt. ii., p. 631, pl. 17, fig. 3. Meek and Worthen, 1866, *Onychocrinus Meeki*, Geol. Rep. Illinois, vol. ii. p. 243. Keokuk limest. Keokuk, Iowa. — 3.
- *1858. *Taxocr. multibrachiatus* Lyon and Case, (Forbesocr. *multibrachiatus*), Amer. Journ. Sci., vol. xxiii. (Labelled in most American collections Forbesocr. *Meeki* Hall.) Keokuk limest. Crawfordville, Ind., and in Kentucky. — 4.
- *1862. *Taxocr. nuntius* Hall. (Forbesocr. *nuntius*), 15th Regt's Rep. N. Y. State Cab., p. 124. Hamilton gr. Erie Co., N. Y. — 1.
1865. *Taxocr. Orbignii* McCoy. Synops. Foss. Brit. Pal. Rocks, p. 53, pl. 1 D, fig. 1. Upper Silur. Westmoreland, Eng. — 2.
- *1860. *Taxocr. ramulosus* Hall. (Forbesocr. *ramulosus*). Supplement Iowa Geol. Rep., p. 67 (not Forbesocr. *ramulosus*, Lyon and Case. — *Onychocrinus ramulosus*). Upper Burlington limest. Burlington. Synon. Forbesocr. *sumbramulosus* Shumard, 1866. — 3.
1851. *Taxocr. Rhenanus* F Roemer. (Cyathocr. *Rhenanus*), Foss. Fauna d. Rhein. Gebirg., p. 7, pl. 2, figs. 2 a-d Devonian. Germany. — 1.
1860. *Taxocr. semiovatus* Meek and Worthen. Proceed. Acad. Nat. Sci. Phila., p. 389, Geol. Rep. Illinois, vol. ii. p. 272, pl. 29, figs. 4 a-b. St. Louis limest. Hardin Co., Ill. — 2.
- *1868. *Taxocr. Shumardianus* Hall (Forbesocr. *Shumardianus*), Geol. Rep. —

B. Subgenus **GNORIMOCRINUS** Wachsm. & Spr.

(γνώριμος, noble; κρίνον, a lily.)

In form and general habitus closely resembling *Taxocrinus*. Arms comparatively longer, figure irregular, lacking the bilateral symmetry of that genus. The basal (subradial) on the posterior side is exceedingly large, reaching almost up to the top of the adjoining first radials. The first anal plate, instead of resting upon the truncated upper side of that basal, leans against the oblique right side and the adjoining first radial. A second series of anals, generally composed of two plates, rests above the basal and first anal plate. All succeeding pieces are small, frequently, but not always, quadrangular, and form as in *Taxocrinus* a short and narrow lateral proboscis which, however, is here pushed over toward the right side of the body, thereby destroying the symmetry which is characteristic of that genus. Arms placed apart, outer face rounded, bifurcating unequally by throwing off branches toward the inner side of the ray, the outer side forming almost a straight line. Column composed of long and short and wide and narrow joints which alternate from the top, not exclusively short joints at the top as in most *Taxocrini*.

We place here the following species: —

- 167* **Gnorimocrinus Austini** Angelin (Taxocr. Austini.) Iconogr. Crin., p. 9, pl. 19, figs. 11 and 11a. Upper Silur. Gotland, Sweden.
- 167* **Gnorimocr. distensus** Angelin (Taxocr. distensus.) Iconogr. Crinoid., p. 9, pl. 26, figs. 7, 7a. Upper Silur. Gotland, Swed.
- 166 **Gnorimocr. excavatus** Shudze (Zocr. excavatus.) Echinol. d. Ed. Kalkes, p. 39, pl. 7, fig. 2. Devonian, Eifel, Germ.

This species differs from the rest in having an excavated base.

- 167* **Gnorimocr. expansus** Angelin (Taxocr. expansus.) Iconogr. Crinoid., p. 9, pl. 20, figs. 15, 16. Upper Silur. Gotland, Swed.
- 167* **Gnorimocr. interbrachiatus** Angel (Taxocrinus interbrachiatus.) Iconogr. Crinoid., p. 8, pl. 29, figs. 9, 10. Upper Silur. Gotland, Swed.
- 167* **Gnorimocr. Loveni** Wachsm. & Spr. (Cyathocr. interbrachiatus Angel.) Iconogr. Crinoid., p. 26, figs. 2, 2a. Upper Silur. Gotland, Swed.

This species differs from *Cyathocrinus* both in the arrangement of the anal plates and in the presence of interradianals. *Gnorimocr. interbrachiatus* being preoccupied, we have named it in honor of Prof. Loven of Stockholm.

* In this species, as also *Gnorimocr. punctatus*, the irregular arrangement of the anal area is not sufficiently shown in the figures, and both may belong to *Taxocrinus*.

- *1876. *Gnorimocrinus oblongatus* Angelin. (*Taxocr. oblongatus*.) Iconogr. —
Crinoid, p. 8, pl. 20, fig. 17. Upper Silur. Gotland, Swed.
- *1878. *Gnorimocrinus ovalis* Angelin. (*Taxocr. ovalis*.) Iconogr. Crinoid, p. 8, —
pl. 20, figs. 13, 14. Upper Silur. Gotland, Swed.
- *1876. *Gnorimocr. punctatus* Angelin. (*Taxocr. punctatus*.) Iconogr. Crinoid, —
p. 9, pl. 23, figs. 4, 5 (fig. 27(?)). Upper Silur. Gotland, Swed.
- *1878. *Gnorimocr. rigens* Angelin. (*Taxocr. rigens*.) Iconogr. Crinoid., p. 9. —
pl. 11, figs. 7, 8. Upper Silur. Gotland, Swed.
- *1878. *Gnorimocr. Balteri* Angl. (*Taxocr. Balteri*.) Iconogr. Crinoid., p. 9, pl. —
23, figs. 1, 1a. Upper Silur. Gotland, Swed.
- *1878. *Gnorimocr. tubuliferus* Angl. (*Taxocr. tubuliferus*.) Iconogr. Crinoid. —
p. 9, pl. 20, figs. 11, 12. Upper Silur. Gotland, Swed.

8. *FORBESIOCRINUS* De Koninck & Lehon.

(Diagr. Pl. 15, Fig. 1.)

1853. *Forbesioocr.*, De Kon. & Leh. Recherches s. l. Crin. Belg., p. 18.
1858. *Forbesioocr.*, Hall. Geol. Rep. Iowa, vol. 1, pl. 2, p. 628.
1866. *Taxocrinus*, Meek & Worth. Geol. Rep. Illinois, vol. II, p. 269.
1878. *Forbesiocrinus*, Angl. Iconogr. Crinoid., p. 9.

A. Typical form.

Comparatively larger than any other genus of the *Ichthyocrinidae*. —
Body, including arms, broad, short, almost equilaterally penta- —
merous. Calyx very large, plates heavy and nodose, radial por- —
tions prominent. Underbasals three, small, hidden by the column, —
two of them of equal size, the third smaller. Basals five, four —
about equal, the one at the posterior side larger, rarely truncated. —
Primary radials three to four by five, generally four, but varying —
in number in the individual; large, almost equal in size and form. —

crease in size gradually upward, the lower one being about half the size of the primary radials.

Axillary plates from ten to twenty and more, with occasionally one to three within the axil of the tertiary radials. Anal area without lateral proboscis or visible aperture, slightly wider than the interrarial areas and similarly arranged, with generally two plates in the first series instead of one. Dome unknown, but evidently to some extent flexible. Column large, tapering downward, with very thin joints next the body; central perforation of medium size, pentagonal.

The most important distinction between *Forbesiocrinus* and *Tarsoocrinus* is to be found in the construction of the anal and interrarial areas. Unfortunately the type specimen of the former genus is in these particular parts very imperfect. We therefore propose, until better specimens of *Forbesiocrinus nobilis* De Kon. & Leh. are discovered, to make *Forbesiocrinus Agassizi* Hall the type of the genus. This large and beautiful species from the Burlington limestone evidently belongs to the same group, and has been found in excellent preservation.

Geographical and Geological Distribution.—*Forbesiocrinus* is not distinguished for a great variety of form, nor for abundance of individuals. In Europe, there has been found only one species from the Mountain limestone of England. In the United States, it is represented by four species, all from the Subcarboniferous.

We recognize the following species as belonging to this genus:

- 1855 **Forbesiocr. Agassizi** Hall (Proposed type). Geol. Rep. Iowa, vol. i, pt. 2, p. 631, also Suppl. Iowa Geol. Rep., p. 65. Upper Burlington limest. Burlington, Iowa. *Synon.* *F. Agassizi* var. *giganteus*, Meek & Worth. Geol. Rep. Illinois, vol. iii, p. 425, pl. 18, fig. 3.
- 1859 **Forbesiocr. Cestriensis** Hall. Suppl. Geol. Rep. Iowa, p. 65. Chester limest. Pope Co., Ill.
- 1853 **Forbesiocr. nobilis** De Kon. & Leh. (original type). Recherches s. l. Crin. Belg. p. 121, pl. 2, figs. 2 a, b. *Potamoocr. nobilis* Phill. is probably a synonym. Mountain limest. Yorkshire, Engl.
- 1854 **Forbesiocr. Wortheni** Hall. Geol. Rep. Iowa, vol. i, pt. 2, p. 632, pl. 17, fig. 5. Keokuk limest. Keokuk, Iowa, and Crawfordsville, Ind.

B. Subgenus **LITHOCRINUS** Wach. & Spr.

(*Lithocr.*, a stone; *crinus*, a lily.)

Prof. Angelin, in the Iconogr. Crinoid. Suec., p. 9, has described several Gotland species under *Forbesiocrinus*, which we propo

to separate subgenerically. They differ from all subcarboniferous species of this group in having larger underbasals, fewer plates in the interradial and anal areas; in exhibiting a strong tendency to a bilateral figure instead of a pentahedral; in having comparatively much larger and higher first, and shorter second and third radials; also in the exceedingly large first interradial and first anal plate. Arms, so far as observed, free above the secondary radials, but only toward the inner side of the ray; the outer side forming almost a straight line. No pinnulae observed. Column round, composed of alternately larger and smaller joints not tapering in diameter downward.

This division embraces the following species:—

- *1878. *Lithocrinus divaricatus* Angell (Forbesocr. *divaricatus*). Iconogr. Crinoid., p. 9, pl. 21, fig. 21, and pl. 28, fig. 3. Upper Silur. Gotland, Swed.
- *1878 *Lithocr. Milleri* Angell. (Forbesocr. *Milleri*.) Iconogr. Crinoid, p. 9, pl. 21, fig. 16, and pl. 28, fig. 1. Upper Silur. Gotland, Swed.
- *1878. *Lithocrinus obesus* Angell. (Forbesocr. *obesus*.) Iconogr. Crinoid., p. 9, pl. 21, fig. 18, and pl. 28, fig. 2. Upper Silur. Gotland, Swed.
- *1878. *Lithocr. robustus* Angell. (Forbesocr. *robustus*.) Iconogr. Crinoid., p. 9, pl. 21, figs. 11, 12. Upper Silur. Gotland, Swed.

9. *ONYCHOCRINUS* Lyon & Casseday.

- 1859. *Onychocrinus*, L. & C. Am. Journ. Sci., vol. xxix. p. 77.
- 1861. *Onychocrinus*, Meek & Worth. Geol. Rep. Illinois, vol. ii. p. 243.
- 1861. *Forbesocrinus*, Hall. Bost. Journ. Nat. Hist., vol. vii. p. 331.

Body extended in five free rays, which are sometimes spread out horizontally; arms resembling the talons of a fowl. Calyx

twenty, perhaps more in some species; the first one large, resting between the first and second radials; the succeeding ones smaller, rapidly decreasing in size and thickness upward, and having an inward curvature. They are followed by very minute, irregular polygonal plates, which form the interr radial portion of the vault. The radial summit areas consist of two rows of somewhat larger plates, alternately arranged, which extend to the ventral covering of the free rays, and probably throughout their full length. In the median portion of the vault, there are six rather thin but large apical dome plates. The summit, when the rays are extended, is not higher than the top of the second radials; general surface depressed. Column heavy, composed of very thin joints, tapering rapidly downward; central perforation above medium size, pentagonal.

Onychocrinus is most nearly related to *Tarocrinus*, with which it is almost identical in the construction of the anal portions. It differs, however, materially in the free rays, the arm structure, and its greater expansive power.

Lyon and Casseday took the free rays to be arms, and the true arms to be pinnule. These authors did not extend the genus to forms like their *Forbesiocer. ramulosus*, which has only four radials instead of five, as stated in their generic formula, though that species has all the other characters of the genus.

Hall has never recognized *Onychocrinus* as a genus, but placed *O. asteriiformis*, a typical form, under *Forbesiocerinus*. Meek and Worthen, evidently considering the small lateral proboscis the principal distinction between *Onychocrinus* and *Forbesiocerinus*, and not knowing that all *Tarocrini* have it, placed all species of this group in which they observed this appendage under *Onychocrinus*.

Geographical and Geological Distribution.—*Onychocrinus* has been found only in the Subcarboniferous of Ireland and the United States; it embraces the following species:—

- 551 *Onychocr. asteriiformis* Hall. (*Forbesiocer. asteriiformis*), Descr. New Crin. Prelim. Not., p. 9, also *Bost. Journ. Nat. Hist.*, vol. vii. No. 2, p. 320. Meek and Worth. *Onychocrinus asteriiformis* (*Geol. Rep.*, Illinois, vol. ii. p. 243. Upper Burlington limest. Burlington, Iowa.
- 556 *Onychocr. diversus* Meek and Worth. *Proceed. Acad. Nat. Sci. Phila.*, p. 254, also *Geol. Rep.*, Illinois, vol. iii. p. 492. Upper Burlington limest. Burlington, Iowa.

1859. *Onychoer. exsculptus* Lyon and Casseday (Typical species). *Am. Journ. Sci.*, vol. 29, p. 78. Keokuk limestone. Hardin Co., Ky., and Montgomery Co., Ind. *Synon.* *Onychoer.* (Forbesioer.) Herwoodi Meek and Worth. *Geol. Rep.*, Illinois, vol. ii. p. 245, pl. 17, fig. 3.
1875. *Onychoerinus magnus* Worthen. *Geol. Rep.*, Illinois, vol. vi. p. 520, pl. 31, fig. 6. St. Louis limestone. Monroe Co., Ill.
1881. *Onychoerinus Monroensis* Meek and Worth. (Forbesioer. *Monroensis*). *Proceed. Acad. Nat. Sci. Phila.*, p. 150. 1886, *Onychoer. Monroensis*, Ill. *Geol. Rep.*, vol. ii. p. 244, pl. 17, fig. 7. Keokuk limestone. Monroe Co., Illinois.
- *1846. *Onychoer. polydactylus* McCoy. (*Taxoer. polydactylus*.) *Synops. Carb.*, Ireland, p. 178, pl. 24, fig. 7. Subcarbon. Ireland.
- *1859. *Onychoer. ramulosus* Lyon and Cass. (Forbesioer. *ramulosus* L. and C., not Hall), *Am. Journ. Sci.*, vol. 28, p. 235. Keokuk limestone. Montgomery Co., Ind.

10. NIPTEROCRINUS Wachsmuth.

1868. *Proceed. Acad. Nat. Sci. Phila.*, p. 341.
1878. *Geol. Rep. Illinois*, vol. v. p. 434.

This genus was originally referred by its author to the *Cyathocrinidæ*, with which, indeed, it agrees in some of its peculiarities, but a full understanding of the true nature of its structure shows that it must be classified with the *Ichthyocrinidæ*. The number of plates which constitute the proximal ring was not then, nor is now, ascertained with certainty, owing to the fact that they extend but slightly beyond the column, and, though we are inclined to think there are but three, we cannot as yet assert it positively. The first radials in some points resemble those of *Cyathocrinus*, being exceptionally large for the *Ichthyocrinidæ*. They have above a deep notched sinus for the reception of the second radial, and each

that organ having been discovered, though we had occasion to examine on this point some remarkably perfect specimens.

Revised Generic Diagnosis.—Body, with arms included, short; the five rays equilateral; arms divergent. Plates of calyx unusually thin, and, as far as the top of the first radials, forming a basin or depressed cup composed of immovable plates. Succeeding plates, though connected laterally, movable.

Underbasals small, scarcely extending beyond the column. Basals much smaller than the first radials, all pentangular and of equal size. Radials three to four by five. First radials comparatively much larger than in any other genus of this family; articulating face concave, and occupying less than one-half the width of the plate; the upper margins on both sides of the scar nearly straight, almost horizontal, scarcely inflected, and supporting the interrarial portions which are rarely preserved, leaving in their place, in the fossil, a wide, open space between the rays. Second and third radials short, often three or four times wider than high, lunulate, resting in the concavity of the preceding plate; the bifurcating plate almost triangular. Succeeding order of plates constructed like those of the arm, only larger, all of them much wider than high, rounded on the back, with distinct waving sutures showing deep sinuities when the arms are closed, and indicating a great mobility in these parts. Arms divergent, tapering gradually; pinnule unknown. No interradians to the top of the first radials, but the succeeding radials, and probably the first plate of the next order, connected by an interrarial integument, the true nature of which has not been fully ascertained, being probably similar to that in *Tarocrinus*, but composed of larger plates. Column round, thick, composed near the calyx of narrow joints.

Only two species are known, and both are from the Burlington Limestone:—

2473 *Nipteroocrinus arboreus* Worthen. Geol. Rep. Illinois, vol. v. p. 435, pl. 4, fig. 8. Lower Burlington limest. Burlington, Iowa.

2464 *Nipteroocrinus Wachsmuthi* Meek and Worth. (Type of the genus.) Proceed. Acad. Nat. Sci. Phila., p. 341, also Geol. Rep. Illinois, vol. v. p. 435, pl. 2, fig. 4. Upper Burlington limest. Burlington, Iowa.

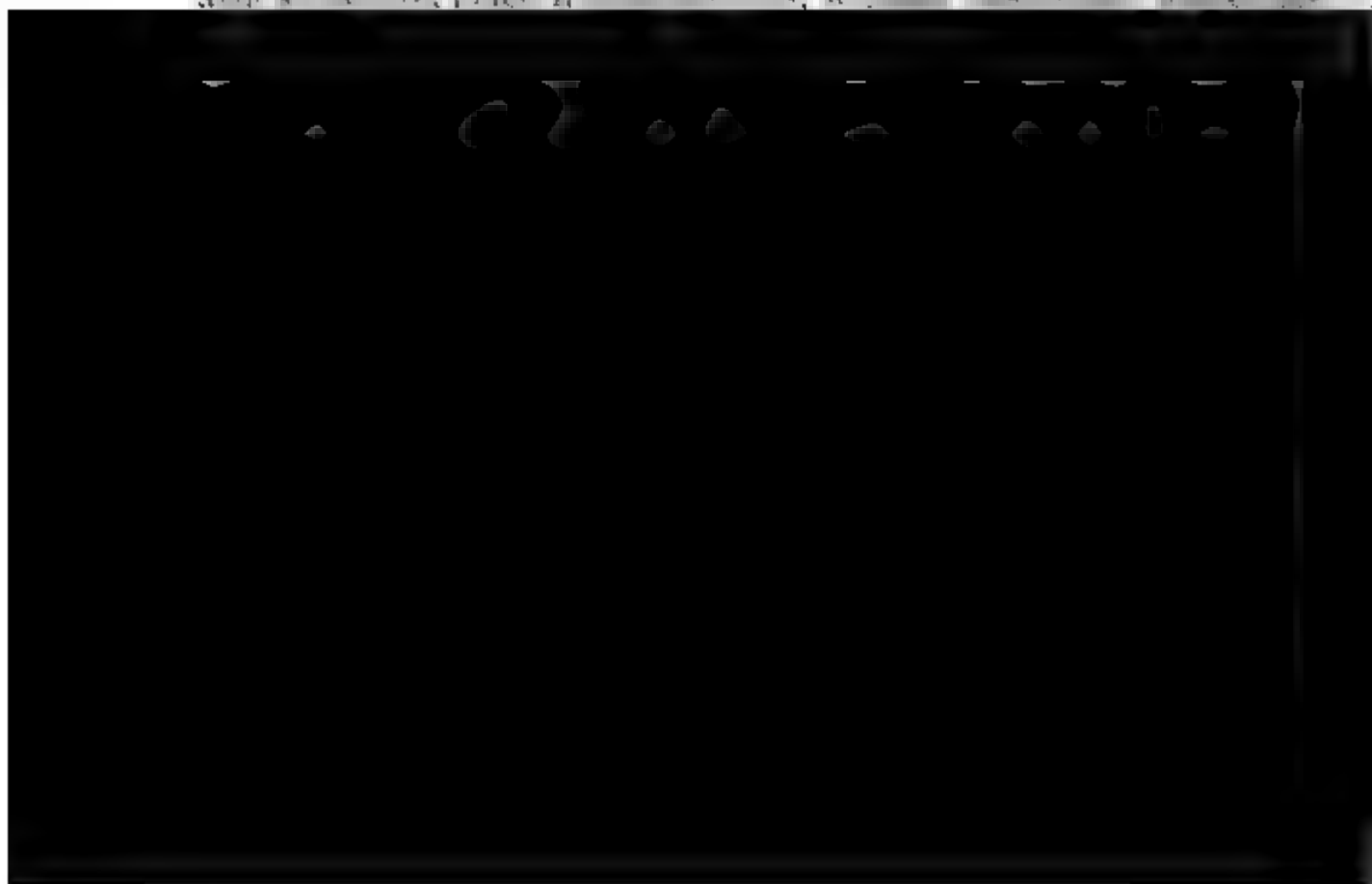
11 RHOPALOCRINUS nov. gen.

(ῥήπαλον, a club, κρίνον, a lily.)

Schultze, in his Monogr. d. Echinod. d. Eid. Kalkes, p. 39, describes a form under the name of *Taxocrinus gracilis*, which is very interesting, inasmuch as it combines, to some extent, the characters of several families. There are only five arms, which remain simple throughout their entire length, forming a straight line with the radials—a peculiarity found in no other genus of the *Ichthyocrinidæ*. This attracted the attention of Schultze, who suggested either a modification of the genus *Taxocrinus*, so as to admit this species, or the recognition of a new genus. In the former proposition we cannot concur, as it seems to us we must admit such peculiarities as exist in this species to be generic distinctions, or throw all forms of the *Ichthyocrinidæ* into a single genus. As to this genus, we even entertain some doubts whether it belongs to the same family.

Our genus *Rhopalocrinus*, with *R. (Taxocr.) gracilis* Schultze, as type, agrees in general form rather with *Cupressocrinus*, *Symbathocrinus* and *Graphiocrinus*—representing as many distinct families—than with *Taxocrinus*; but it differs from all of them in having a series of small plates inclosed between the rays. These plates, which Schultze calls “interbrachials,” fill up, according to his description, “the intermediate spaces to the top of the second radials,” being thus included within the body. If we were sure that this was the case, we should, notwithstanding the simple

arm structure, place *Rhopalocrinus* with *Cupressocrinus* and *Symbathocrinus*.



course would remove *Rhopalocrinus* from the *Ichthyocrinidæ*, and bring it in close relation with such genera as *Symbathocrinus* and *Pisocrinus*, with which it agrees in its arm structure and in the narrow proboscis, which probably extended in those genera to the extremities of the arms.

We propose the following generic diagnosis: General form of body, including arms, subclavate, with bilateral symmetry; plates heavy. Underbasals three, scarcely visible beyond the column. Basals five, four of them equal, regularly pentangular, the fifth much higher, becoming narrower toward the top, truncated above for the accommodation of the proboscis. Radials placed in a direct line with the arms; one ring only constituting a part of the solid body, all succeeding ones being more or less movable. First radial large, heavy, the articulating face occupying almost the entire width of the plate, circular, facing slightly outward, and perforated with an opening which communicates with the interior body and with a passage toward the dorsal side of the arms. Second radials, or first brachial plates, wide but short, evidently movable, probably connected interradially (between the rays) by small polygonal plates. Succeeding plates all of the same width and form as those of the preceding ring; their height, however, three or four times greater. Arms five, simple throughout, and closely resembling those of *Symbathocrinus*; length unknown, of almost uniform size up to the sixth plate. Ambulacral furrow covered by two rows of plates roofed together, with the median line elevated. Anal area supporting a lateral proboscis similar to that of *Onychocrinus*, but heavier, and probably extending up to the top of the arms, as in *Symbathocrinus*. Interradial spaces apparently filled by very small, uneven polygonal plates up to the second brachial. Column large, almost cylindrical, and composed of larger and smaller joints near the body.

The only known species is—

- 1466 *Rhopalocrinus gracilis* Schultze. (*Taxocr. gracilis* Schultze, not *Taxocr. gracilis* Meek and Worth.) Monogr. Echinod. Ertl. Kalkes, p. 39, pl. 4, figs 3, 3 a. Devonian. Eifel, Germ.

FAMILY II.—CYATHOCRINIDÆ.

The Cyathocrinidæ represent not only one of the largest but also one of the earliest groups of the Palæocrinoidea, and they survived every other family of that sub-order.

J. S. Miller, the author of *Poteriocrinus* and *Cyathocrinus*, the two principal genera, placed the former among the Semiarticulata and the latter under the Inarticulata, which he understood to represent two distinct families. *Poteriocrinus*, according to his views, had the plates of the calyx articulating imperfectly with each other, while the plates of *Cyathocrinus* were closely joined by sutures lined with muscular integument. It is unnecessary to examine Miller's divisions in detail, as they are based upon theory and incorrect observation, as is further shown by the fact that under the Inarticulata he united *Cyathocrinus* with *Actinocrinus*, *Rhodocrinus* and *Platycrinus*, which are of course totally distinct.

Thom. Austin's classification (1843, Rec. and Foss. Crin.) is equally unsatisfactory. He followed Miller in separating *Cyathocrinus* and *Poteriocrinus* into two distinct families, placing the former among the Platycrinidæ, and including therein *Caryocrinus*; and *Poteriocrinus* with *Symbathocrinus* among the Poterocrinidæ. The former group is based simply upon the presence of but few plates in the calyx. In the Poterocrinidæ, according to Austin, "the lower series of plates surrounding the body, rest on and articulate on the superior columnar joint, which also articu-

(1855, *Lethæa Geognostica*, Ausgabe III., Period I), who went to the opposite extreme by uniting Miller's typical species of *Cyathocrinus* with *Poteriocrinus*, and placing the latter with *Wendocrinus*, *Homocrinus*, *Dendrocrinus*, *Mespilocrinus*, and *Thysanocrinus* under the *Poteriocrinidae*. It has been explained elsewhere that Roemer adopted the generic name *Cyathocrinus* with Miller's *Cyathocrinus tuberculatus* as type for another group of Crinoids, which had been previously separated by Phillips under *Tarocrinus*, and ranged these with *Ichthyocrinus* and a number of other genera under the family name "*Cyathocrinidae*." It will thus be understood that Roemer's *Cyathocrinidae* really represent our *Ichthyocrinidae*, and his *Poteriocrinidae* our *Cyathocrinidae*. He united in the former an assemblage of very distinct groups, and among his *Poteriocrinidae* are found *Mespilocrinus*, which, as we believe, belongs to the *Ichthyocrinidae*, and *Thysanocrinus*, which is distinct from any of these families.

Angelin, in his systematic arrangement of the Gotland Crinoids (*Leogn. Crin. Suec.*), very correctly places *Seyocrinus*, *Eupycnocrinus*, *Ophiocrinus*, and *Botryocrinus* among the *Cyathocrinidae*; but *Glassocrinus*, which closely agrees with *Cyathocrinus*, except in having three underbasals instead of five, he classes (apparently on account of this structure alone) with the *Forbesiocrinidae*. We have already, in our introductory remarks, noted the difficulty of classifying the genera according to the number of proximal plates, and in *Glassocrinus* we have a good example of this.

A close and comparative study of the genera *Cyathocrinus* and *Poteriocrinus* has convinced us that, though the two are very distinct generically, they are, as between themselves and in connection with many other genera, united by very important structural features, and by right ought to be regarded as of one family. They all agree—

1. In having large oral plates supporting the ambulacral grooves and covering the ventral disc, but leaving an opening at the oral centre, which is perfectly covered by the apical dome plates. Food grooves along the vault closed by two rows of alternating pieces.

2. In the presence of a porous ventral sac, located posteriorly, and closed at the top, in which the anal functions were subordinate to other offices, probably in connection with respiration and

perhaps reproduction. Anal opening rarely observed, evidently lateral—not posterior—and low down.

3. In having the calyx constructed of only three rings of plates alternating with each other. Proximal or underbasal plates sometimes imperfectly developed or even wanting, the plates of this order rarely anchylosed. No interradians, but anal plates generally found within the calyx.

These are the dominant characters upon which we propose to establish the Cyathocrinidae as a family.

An attempt to subdivide this family by means of differences in the construction of the anal area and presence or absence of pinnulae into two groups, represented by *Poteriocrinus* and *Cyathocrinus*, proved unsuccessful. It is true the two typical genera are well distinguished by these characters, and most genera from the Carboniferous might readily be separated in this way; but it would be very difficult with the Silurian genera, in which the anal area is imperfectly developed. Such a division might possibly be established if we had before us the living types instead of fossils, and it is very likely that the earlier forms, which include *Heterocrinus*, *Iocrinus*, *Dendrocrinus*, *Carabocrinus*, *Hybocrinus*, and *Anomalocrinus*, in which the proximal plates or underbasals are as yet very small and scarcely visible, might also be arranged in a division by themselves. So, too, *Woodocrinus*, *Zeacrinus*, *Hydreionocrinus*, and *Carliocrinus* are well characterized by their enormous balloon-shaped ventral sac, and in like manner *Eupachyocrinus*, *Erisocrinus*, and *Stemmatocrinus*, by the dwarfing of the same organ to its minimum size, represent a transition in the direction of the Encrinuridae. All these groups apparently have some claim to be classed independently, but in doing so we should rather increase than diminish the difficulties before us, and gain nothing in the end. The genera are so closely linked together, and shade so easily from one to another, and from one group into another, that a satisfactory separation is next to impossible. But, in order to facilitate the comparative study of the genera, we have arranged them systematically in such a manner that allied types are brought together in the order in which they pass into one another, and we are confident that this arrangement will materially assist in the recognition of the genera.

The following is the list:—

CYATHOCRINIDÆ.¹

Earlier or embryonic types:—

- | | |
|---------------------------------------|----------------------------------|
| 1. <i>Heterocrinus</i> Hall. | 4. <i>Hybocrinus</i> Billings. |
| 2. <i>Iocrinus</i> Hall. | Subgenus <i>Homocrinus</i> Hall. |
| 3. <i>Anomalocrinus</i> Meek & Worth. | 5. <i>Dendrocrinus</i> Hall. |

Typical Cyathocrinidæ:—

- | | |
|---|-----------------------------------|
| 6. <i>Cyathocrinus</i> Miller. | 11. <i>Ophiocrinus</i> Angelin. |
| 7. <i>Lezythocrinus</i> Zittel (J. Müller). | 12. <i>Betryocrinus</i> Angelin. |
| 8. <i>Gisocrinus</i> Angelin. | Subgenus <i>Sicyocrinus</i> Angl. |
| 9. <i>Aracnocrinus</i> Meek & Worth. | 13. <i>Burgerinus</i> Wachsmuth. |
| 10. <i>Vauocrinus</i> Lyon. | |

Poteriocrinus type:—

- | | |
|--|---|
| 14. <i>Poteriocrinus</i> Miller. | Subgenus <i>Deudocrinus</i> |
| Subgenus <i>Scaphiocrinus</i> Hall | W. & Spr. |
| (modified by W. & Spr.). | 15. <i>Graphiocrinus</i> de Kon. & Leh. |
| Subgenus <i>Pariocrinus</i> W. & Spr. | Subgenus <i>Bursocrinus</i> |
| Subgenus <i>Pachylocrinus</i> | Meek & Worth. |
| W. & Spr. | Subgenus (?) <i>Phidocrinus</i> |
| Subgenus <i>Seytuloocrinus</i> W. & Spr. | Trantschold. |

¹ Since writing our classification, Prof. Zittel of Munich, with whom we have exchanged notes informs us that he has separated the genera which we have united under Cyathocrinidæ into four families. (Handbuch der Petrefactenkunde, 3te Lieferung, now in press.)

- | | |
|-------------------|--|
| 1. Hybocrinidæ | } without pinnulæ, arms covered with plates. |
| 2. Cyathocrinidæ | |
| 3. Poteriocrinidæ | } with pinnulæ. |
| 4. Heterocrinidæ | |

We doubt whether this division can be maintained practically. *Heterocrinus* is certainly more closely related to *Hybocrinus*, which he disposes under a separate family, than to *Graphiocrinus*, *Phidocrinus*, *Eriocrinus*, and *Stemmatocrinus* with which he groups it. The variety of *Poteriocrinus*, which we have proposed to call *Seytuloocrinus*, has such close affinities to *Graphiocrinus* that it might well be doubted whether it would be considered as a subgenus of *Poteriocrinus* or *Graphiocrinus*. If a division of the Cyathocrinidæ should prove desirable, it would seem to us more natural to bring together *Heterocrinus* with *Hybocrinus* and *Anomalocrinus*, and to place *Graphiocrinus* and allied genera under the Poteriocrinidæ; but this would interfere with the division according to pinnulæ. The difficulties in the way of a subdivision, which we have discussed at length in our general remarks on the family, do not seem to us to outweigh the proposed arrangement of our distinguished col-

Zeacrinus type:—

16. *Woodocrinus* de Koninck.
17. *Zeacrinus* Troost.

18. *Hydreionocrinus* de Koninck.
Subgenus(?) *Calioocrinus* White.

Transition forms toward *Encrinus*:—

19. *Eupachyrcrinus* Meek & Worth. 21. *Stemmatoocrinus* Trautschold.
20. *Erisocrinus* Meek & Worth.

Genera insufficiently known:—

22. *Euspiroocrinus* Angelln. 25. *Pachyocrinus* Billings.
23. *Carabocrinus* Billings. 26. *Myelodactylus* Hall.
24. *Cyrtidocrinus* Angelln.

In some species of *Heterocrinus*, one of the oldest of known genera, the underbasals or proximal plates are apparently wanting; in others they are so imperfectly developed that Meek did not think proper to recognize them by the usual term, but called them sub-basals. If it happens that these plates are absent, as seems to be sometimes the case, in species which apparently belong to the same genus, it would seem improper to separate *Heterocrinus* on that ground alone, and this consideration has induced us also to place in this family, at least for the present, the allied genera *Hybocrinus* and *Anomalocrinus*, in which as yet no trace of these plates has been discovered, but which otherwise have all the characters of the typical Cyathocrinidæ. The family relations as to these genera are not altogether clear, and it will require further study and better material before we can expect to understand them fully. For the present we will content ourselves with drawing attention to their anomalous position in the structure of

apparently in the Actinoecrinidae and Platycrinidae. This might have induced us to place *Heterocrinus* and *Ioecrinus* in a separate division along with *Hybocrinus* and *Anomalocrinus*, which latter two evidently belong to the same group, if we had not discovered that the same diversity of structure apparently exists in species of another family. In all *Pentacrinus*, recent or fossil, that have come under our observation, the cirrhi are radial and the ridges interradial, with the exception of *Pentacrinus Johnsoni*, in which according to Austin's figure (Rec. and Foss. Crin., Pl. 15, Fig. i.) the cirrhi are situated interradially as in *Ioecrinus*. Owing to this interesting coincidence, and also to the fact that in *Dendrocrinus*, which in many respects closely resembles *Heterocrinus* and its above-named associates, this columnar structure is the same as in all typical genera, we have retained these genera for the present in this family. We also retain those genera in which the five underbasals are metamorphosed into three, as in *Groecrinus*, contrary to Angelin and Zittel, or into a single plate, as in *Stemmatocrinus*, provided they otherwise agree with the family.

In the Cyathocrinidae, the anal area, though constructed of comparatively few plates, affords most excellent generic distinctions in their arrangement. We note two principal forms; the one, which we may call the *Poteriocrinus* form—as it is best illustrated in that genus—is generally composed of three plates in the calyx, which are arranged unsymmetrically and always directed toward the right side of the body; the other, or *Cyathocrinus* anal arrangement, with a bilateral symmetry, consists of a single plate, which rests upon the truncate posterior basal. The former occurs in connection with regular pinnule along the arms; in the latter the arm furrows are covered by small alternate pieces and the pinnule are wanting.

There is scarcely any difficulty in referring all Cyathocrinidae, from the Upper Silurian to the close of the Carboniferous, to one of those two groups, though the anal plates vary in form more or less in every genus. In genera from the lower Silurian this is more difficult. Yet there appears to exist even among the latter and in connection with all others, an easy gradation which indicates that both forms had very probably the same origin, and that the later ones were gradually developed from the earlier Silurian types.

Looking first at the subgenus *Joerinus*, one of the early known forms of Crinoids, we find the body up to the top of radials perfectly equilateral, all basal and radial plates having same form; but higher up this symmetry becomes disturbed by irregularities in the disposition of the brachial plates. There are four brachials in four of the rays, short and all quadrangular while the right posterior radial supports a peculiar bifurcating plate of the same width as the other brachials and apparently similarly articulated. Its right sloping side supports four brachials, its left a number of large, heavy, almost quadrangular plates, longitudinally arranged, rounded on the back, which have the general appearance of arm plates, and such they have been taken to be by most authors. They are, however, plates of a rather strong ventral sac, and extend to its full length forming a highly elevated ridge (Pl. 16, Fig. 3). The plates are bordered on each side by about double their number of rather delicate pieces, altogether different and transversely arranged, which from their peculiar elongate form and relative position resemble pinnulae belonging to an appendage that looks like an arm. Now the question arises, what shall we call the bifurcating plate which gives rise both to the right posterior ray and to the ventral tube? It was certainly a movable plate, and as we mentioned before, its mode of articulation was evidently the same as that of the brachials. Shall it likewise be called a brachial? And again, was not the ventral tube here, and in Crinoids generally, originally a modified arm? This, if true, would at once explain why the anal area leans always toward the right and never to the left side of the body. Is the plate, on the contrary, an anal plate? If so, the arms in that ray would rest upon the base of the proboscis, which is not very probable. That it is a brachial with interradial functions, is illustrated in other genera. In *Dendrocrinus*, as may be seen, Pl. 16, Fig. 5, the case is substantially the same, but in that genus a regular anal plate has already appeared within the calyx, supporting the ventral sac. Here four of the *radials* are equal instead of four brachials, and the fifth is a compound plate consisting of two successive plates of about the form of the simple ones, but slightly larger. Nobody can doubt that here both the upper and lower sections of the compound plate, which are separated by a horizontal suture, are strictly radial. Looking, however, at *Homocrinus*, Pl. 16, Fig. 6, it will be found, although it differs

Dendrocrinus only in having the suture between the sections of the compound plate sloping instead of horizontal, that by this a self-trifling alteration, which required no modification in the construction of other plates, the lower portion of the equal compound radial became transformed into an anal plate. This was the first step towards a *Poteroocrinus* anal arrangement, and in fact to complete it required only the interposition of a third such plate (Pl. 16, Fig. 7). In confirmation of this idea it is very significant that *Dendrocrinus* is essentially a Lower Silurian genus, that *Homocrinus* is restricted to the Niagara group, and *Poteroocrinus* is pre-eminently a subcarboniferous form.

The step from *Dendrocrinus* to *Cyathocrinus* (Pl. 16, Fig. 8) was equally simple, and required only the consolidation of the compound plate into one, the simple anal plate being already developed in the former. Sometimes, however, in genera wherein otherwise the *Cyathocrinus* anal arrangement prevails, there is found alongside of the single anal plate in some species—occasionally only in a few specimens, and in *Rangierina* and *Botryocrinus* almost as a rule—a supplementary anal piece obliquely interposed toward the right side, standing as a witness to the common origin of this and all anal plates. That there has never been observed a single instance in which the anal area was directed toward the left—not even an abnormal case—is most significant, and is strong evidence in favor of our opinion, that the ventral sac originated in the right posterior ray. It proves also that the modifications which we have mentioned as taking place in the family in geological succession, are occasionally found within the limits of a genus.

It is to be regretted that the ventral sac, owing to its position, hidden between the arms, is so rarely observed. A better knowledge of this organ, we have no doubt, would enable us to base upon it excellent generic distinctions, and it might perhaps assist in establishing subdivisions in this family. Very little is known, for instance, of the distribution and position of the pores and fissures, of the anal opening, etc., and nothing as to its internal organization.

In the Lower Silurian the ventral sac attained large dimensions. In the age of the Niagara group, Upper Silurian, it became remarkable for its singular form, in some genera coiling upon itself, or bending in all directions. In the Devonian and earlier Subcar-

boniferous it attained the maximum in length, and the cylindrical form prevails, but this by degrees changed into the club-shaped form, from which in the succeeding geological epochs, toward the close of the Subcarboniferous, those monstrous balloon-shaped sacs were developed, and with these, as if a culmination had been reached, the family actually terminates. The few forms which still survive can no longer be considered as true types of the Cyathocrinidæ. They are of a type prophetic of a new family which is soon to appear, and of which *Enerinus* is the leading genus. The resemblance of *Stemmatocrinus* to *Enerinus* is indeed so strong that one may well hesitate in which of the two families—Cyathocrinidæ or Enerinidæ—it should be classed. We should probably have decided in favor of the latter, if we had seen any possibility of separating *Stemmatocrinus* from *Eupachyrcrinus*, and *Eupachyrcrinus* from *Poteriocrinus*, and so on. The only real difference which we notice between the two is that in *Enerinus* the three rings of plates which form the calyx, in the Cyathocrinidæ constitute an almost flat disc, or so shallow a cup that there would be no space for a visceral cavity if covered by solid plates, and, as no trace of a ventral covering has ever been observed, it is very probable that *Enerinus* belongs to the Stomatocrinoidea.

The free floating *Agasizocrinus* (*Astylocrinus* Roemer) is another form, in regard to which doubts might be entertained whether it ought not to be ranked with the Cyathocrinidæ. Its younger stage, wherein it was pedunculate, agrees well in general structure with *Eupachyrcrinus*, and is very appropriately called the Cyathocrinoid form. We think it better, however, to separate the genus by itself, as in the case of *Pentacrinus* and *Comatula*, and to place it under *Astylocrinidæ* in a distinct group.

General Family Diagnosis.—Calyx composed of only three rings of plates alternating with each other, each ring composed of five plates; all succeeding plates free. The proximal ring or underbasals not unfrequently hidden from view by the column, perhaps in some cases wanting, rarely anchylosed so as to form three plates or a single one. The plates of the second ring generally varying in form, the posterior one frequently truncate. Those of the third ring or the radials, more or less pentagonal, the right posterior one often smaller on account of interposed anal plates. The succeeding order of plates which have been generally design-

nated as "free radials," but for which we have adopted the term "brachials," consists of one to two or more by five plates on which the arms originate.

Arms simple or branching, comparatively long; either provided with rather strong pinnule, alternately arranged, or, in the absence of these, the ambulacral groove is covered with two rows of alternating pieces, more or less wedge-shaped, sometimes strongly cuneiform, and interlocking.

There are from one to four anal plates within the calyx. When there is a single anal, the symmetry of the body is generally bilateral, but, in case of two or more, the form is irregular, because the plates tend obliquely toward the right side of the body. The anal plates support a ventral sac, which is cylindrical, convoluted, club- or balloon-shaped, and which occasionally attains immense proportions. The sac is bordered with rows of pores or fissures; its upper extremity closed, so far as observed; the anal opening lateral. Interradial plates proper entirely wanting.

Calyx surmounted by five large oral plates, with a central opening between them, and forming at their sutures five shallow ambulacral grooves converging toward the centre. Central opening covered by the apical dome plates, and the five grooves arched over by two rows of small immovable pieces, alternately arranged.

Column round or pentagonal.

The *Cyathocrinidae* differ from the *Ichthyocrinidae* in having a solid inflexible vault, built up of oral plates, in possessing but a single radial to each ray; and in the absence of interradsial plates.

1. *HETEROCRINUS* Hall.

(Diagram Pl. 10. Fig. 2.)

1843. Hall. Geol. Rep. New York, vol. 1. p. 278.

1859. Belings. Geol. Surv. Canada, Decade IV. p. 48.

1865. Meek and Worthen. Proc. Acad. Nat. Sci. Phila., p. 147.

1866. Hall. 24th Rep. N. Y. State Cab. Nat. Hist., p. 210.

1873. Meek. Geol. Surv. Ohio. Palaeont., vol. 1. p. 2.

The genus *Heterocrinus* varies from the typical *Cyathocrinidae* in several important particulars: first, in the apparent absence of underbasals in some of the species; second, in certain irregularities in the radial plates. In the former respect it agrees with *Hypocrinus* and *Acronalocrinus*, in the latter with *Demicrinus*.

The irregularities in the radial parts seem at first sight to be

totally at variance with the elementary plan of structure in the family, as the calyx here appears to be composed of more than five radial plates, some of the rays having apparently two or even more. Looking at Diagram Pl. 16, Fig 2, showing the arrangement of plates in *H. simplex* Hall, it will be found that in the anterior and right posterior rays, there are three plates in succession, whereas there are four in each of the other rays. But it will be also observed that the first radial plate in the former is about equal in size to the first two plates combined in the three other rays. It is, therefore, not unreasonable to suppose that the two here represent a compound plate, and are homologous with the single radial in other Cyathocrinidae. This interpretation fully restores the family relations, the two succeeding plates being considered as true brachials. A similar construction exists in *Dendrocrinus*, but there only the left posterior radial is compound.

The absence of underbasals in some of the species is a good illustration of our view that the underbasals do not constitute principal elements in the structure of the Palaeocrinolea, but are merely the result of growth and development in geological time. Even Meek, who calls the proximal plates in all other genera of the Cyathocrinidae basals, substitutes for those of *Heterocrinus* the name "subbasals."

Generic Diagnosis.—General form elongate and slender. Calyx small, subcylindrical, tapering but slightly from the column upward.

Underbasals minute, in some species almost undeveloped, and appearing externally as subtrigonal points at the lower ends of the sutures between the basals; in some species apparently wanting entirely. Basals five, subequal, pentangular. Radials irregular; some of the rays differing from those of other genera in having compound instead of simple plates, which are divided by horizontal sutures; upper articulating margin straight. The radials are succeeded by two to four brachials, quadrangular, the upper one a bifurcating plate and supporting the arms.

Arms comparatively long, simple or branching, composed of single joints with almost parallel suture. Pinnulae heavy, springing alternately from every second or third arm plate.

Anal not supported by the basals, but resting upon the upper sloping margins of the adjoining radials. They consist of a single row of plates, longitudinally arranged, the outer side rounded

and forming a prominent ridge, which gives the appearance of an arm.

The ventral sac in this genus is but imperfectly known, but it is apparently not so robust as in *Iocrinus*. Column more or less pentagonal.

The genus *Heterocrinus* is known exclusively from the Lower Silurian, and has been found only in America, unless *Myelodactylus* (?) *heterocrinus* Angl., from the Upper Silurian, belongs to it.

The following species have been discovered:—

1859. *Heterocrinus articulatus* Billings. Geol. Rep. Canada, Dec. iv. p. 51, pl. 4, fig. 8. Trenton limest. Ottawa, Canada.
1866. *Heterocr. constrictus* Hall. 24th Rep. N. Y. State Cab. Nat. Hist., p. 210; also Geol. Surv. Ohio, Palæont., vol. i. p. 3, pl. i. figs. 10 a, b. Hudson River Gr. Cincinnati, O.
H. constrictus (var.) *contractus* Meek, 1873. Geol. Surv. Ohio, vol. i. p. 4, pl. i. fig. 11. Ibid.
1866. *Heterocr. exilis* Hall. 24th Rep. N. Y. State Cab. Nat. Hist., p. 213, pl. 5, fig. 16. Hudson River Gr. Cincinnati, O.
H. exilis (var.) *exiguus* Meek, 1873. Geol. Surv. Ohio, Pal., vol. i. p. 5, pl. i. fig. 12. Ibid.
1843. *Heterocr. heterodactylus* Hall. (Type of the genus.) Geol. Rep. N. Y., vol. i. pl. 76, fig. 11 a—c; also Geol. Surv. Ohio, Pal., vol. i. p. 12, pl. i. figs. 1 a, b (2 a, b?). Hudson River Gr. Ohio and New York.
1859. *Heterocr. inæqualis* Billings, Geol. Rep. Canada, Dec. iv. p. 51, pl. 4, fig. 7. Trenton limest. Ottawa, Canada.
1866. *Heterocr. juvenis* Hall. 24th Rep. N. Y. State Cab. Nat. Hist., p. 212, pl. 5, figs. 9, 10; also Geol. Rep. Ohio, Pal., vol. i. pl. i. figs. 3 a—c. Hudson River Gr. Cincinnati, O.
1866. *Heterocr. laxus* Hall. 24th Rep. N. Y. State Cab. Nat. Hist., p. 211, pl. 5, fig. 15; also Geol. Rep. Ohio, Pal., vol. i. p. 14, pl. i. figs. 8 a, b. Hudson River Gr. Cincinnati, O.
1843. *Heterocr. simplex* Hall. Geol. Rep. N. Y., vol. i. p. 280, pl. 76, figs. 2 a—d, also Geol. Surv. Ohio, Pal., vol. i. p. 7, pl. i. figs. 4, 5 (6, 7?). Hudson River Gr. Cincinnati, O.
Syn. Heterocr. Canadensis Billings, 1859. Geol. Rep. Canada, Dec. iv. p. 48, pl. 4, fig. 5.
1856. *Heterocr. tenuis* Billings, Geol. Rep. Canada, p. 273; also Dec. iv. p. 50, pl. 4, figs. 6 a, b. Trenton limestone. Ottawa and Montreal, Canada.

3 IOCRINUS Hall.

(Diagram Pl. 16, Fig. 8.)

1866. Desc. New Spec. Crin. by J. Hall, p. 5; reissued in 1873 in the 24th Rep. N. Y. State Cab. Nat. Hist., p. 210.

Prof. Hall, in re-describing *Heterocrinus subcrassus* Meek & Worth. as *Heterocr. (?) polyxo*, made use of the name *Iocrinus*

for a subgenus. It seems that he was in doubt whether *Iocrinus* should be placed with *Heterocrinus* or *Poteriocrinus*, as he supposed these two genera to be closely related. In this Hall is certainly in error, since a close comparison proves them to be very distinct. Neither can we conceive how such forms as *Iocrinus crassus* can be referred to *Heterocrinus*. The two differ essentially in the anal arrangement, and in the form and construction of the radial plates, which are perfectly symmetrical and simple in the former, but irregular and compound in the latter. Such characters have heretofore always been considered of generic importance, and we accordingly adopt Prof. Hall's name but in a full generic sense, and propose for the genus *Iocrinus* the following:—

Generic Diagnosis.—General appearance somewhat similar to *Pentacrinus*; comparatively larger than *Heterocrinus*; arms longer and more frequently bifurcating; calyx more broadly spreading, and perfectly symmetrical up to the top of the radials, giving the form of a short, inverted, pentagonal pyramid with the five sides deeply concave.

Underbasals undeveloped. Basals small, pentagonal. Radials comparatively large, strong, all pentagonal, and of the same height; their upper margins truncated for nearly their entire breadth for the junction of the succeeding pieces. Brachials three to four in each ray, the upper one axillary, and supporting the first free divisions of the arms. In the right posterior ray there is interposed between the true brachials and radial plate a pentagonal bifurcating piece, which is evidently free and movable like the brachials, and of the same width. This peculiar plate, which is truly radial, supports on its right sloping side the usual number of brachials, and on the left a row of quadrangular plates, vertically arranged, extending to the tips of the arms, and forming the posterior wall of a large ventral tube. In external appearance these plates resemble the brachials and arm plates, only they are somewhat higher and not quite as wide; they are gibbous, and form an elevated ridge, which causes this appendage to resemble an arm or a branch of the ray, and so it was considered by Hall in his description of *Heterocr. polyzo.* Both sides of the mesial ridge are indented to accommodate other plates, of which there are two to each median plate, one abutting against the middle part, and the other opposite the suture. These lateral plates are delicate, three or four times wider than high, and, like the other,

longitudinally arranged. Each of them contains a rather deep furrow, which in perfect specimens is arched over by a row of wedge-shaped plates which stand out prominently and appear very much like pinnule.¹

Arms bifurcating frequently, gradually tapering; arm pieces, like the free radials, all projecting at the upper edge, thereby producing a sort of imbrication. Pinnule unknown.

Column strong, distinctly pentagonal, the angles in line with the radial plates of the body.

Geological position.—Lower Silurian.

The following two species are the only examples of this genus:—

- *1865 *Ioerinus crassus* Meek & Worthen (*Heterocr. crassus*), Proc Acad Nat Sci Phila., p 147—also Geol Rep Ill., vol III p 325, pl 4, figs 1 a-c also vol vi, pl 23, fig 1 Hudson River Gr Oswego, Ill.
 - *1865 *Ioer subcrassus* Meek & Worthen (*Heterocr. subcrassus*), Proc Acad Nat Sci Phila. p 148, also Geol Rep Ill. vol III p 325, pl 4 figs 5 a-d also Meek, *Heterocr. (Ioerinus) subcrassus*, Geol Surv Ohio, Pal., vol I p 15, pl 1 figs 9 a, b Hudson River Gr Cincinnati Ohio.
- Syn *Heterocr* (? *Ioerinus polyxo* Hall, 1866 34th Rep. N Y St Cab Nat Hist p 210

3. *ANOMALOCRINUS* Meek and Worthen.

(Diagram Pl 10 Fig 1.)

- 1865 *Heterocrinus* (?) (*Anomalocrinus*) Meek & Worth. Proc. Acad. Nat Sci Phila., p 148.
- 1868 *Heterocrinus?* (*Anomalocrinus*) Meek & Worth. Geol. Rep Ill. vol III p 327.
- 1869 *Ataxocrinus* Lyon Am Philos. Soc., vol xlii p 464.
- 1873 *Anomalocrinus* Meek Geol Surv Ohio, Pal., vol. I p. 17.

Generic Diagnosis.—General form of the crinoid depressed, calyx comparatively large, depressed subglobose, its form extremely irregular, scarcely two plates being of the same shape.

Under-arms unknown, and perhaps undeveloped. Basals five, small, subequal, pentagonal, wider than high, partly hidden by the column. Radials very large, of diverse forms, simple or compound, the latter divided either horizontally or vertically. Of the com-

¹ It was to this peculiar structure that we alluded in our remarks on this family and the similarity in the appearance of the ventral sac and the arms and pinnule is indeed most striking. If there is in nature any such thing as a transmutation of one organ into another, it would seem that such was the case here, and this may lead to a better understanding of the functions of the ventral sac.

pound plates, those that are divided by horizontal sutures, occur in similar rays as in *Heterocrinus*, being always found in the right posterior and either in the left lateral, or in the anterior ray. The radials of the remaining rays are either simple or bisected vertically, the two halves taken together being similar in form to the simple plates. The lower segment of the former compound plates is subquadrangular, the upper one axillary and pentagonal, its lower edge slightly concave to fit the convexity of the abutting margin below. The rays with simple radials have generally fewer brachials than those with compound plates, and this gives to the Crinoid that abnormal, irregular appearance which is the most characteristic feature of the genus.

Arms divergent at their origin; long, slender, bifurcating irregularly several times above, the divisions being often of unequal size; rounded, and composed each of a single range of pieces. Pinnulae strong. First anal plate resting transversely between the upper sloping sides of the posterior radials; succeeding plates smaller and longitudinally arranged.

Column stout, round, composed of very thin discs or segments, and having near the base a large pentagonal opening. The segments have the appearance of being composed of numerous little anchylosed spicula of irregular size and form (Meek).

Anomalocrinus has its closest affinities with *Heterocrinus*, to which it was referred in 1865 by Meek and Worthen as a subgenus. Not so apparent are its relations to *Hybocrinus*, with which the same authors afterwards similarly combined it. It certainly differs from them both very distinctly in the shallow and depressed

4. **HYBOCRINUS** Billings.

(Diagram Pl. 16, Fig. 4.)

1856. Geol. Surv. Canada, p. 274, and Dec. IV. p. 28.

(*Apiocrinites* Leuchtenberg, *Haplocrinus* Grewingh, *Homocrinus*, p. p. Elchw., *Beroocrinus* Volborth, are synonymous. See Zittel's Handb. d. Petrefactenkunde, p. 850.)

Calyx globular or pyriform, one side protuberant; composed of 5 basals, 5 radials, and 2 anal plates.

Underbasals not observed, and probably rudimentary. Basals of equal size, pentagonal. The next ring of plates consists of a large anal and four of the radials, all nearly equal in size, and alternating regularly with the basals. The anal plate is hexagonal, its two upper sides equal, the sloping right side supporting a small radial, the left a second anal plate. Both of these plates are wider than high, of about the same size, which is about one-third that of the plates below. They are separated by a vertical suture, and rest by their outer edges against the upper portion of the adjoining radials which are octagonal, while the other two are heptagonal.

Arms five, simple throughout, composed of rather heavy quadrangular joints, about as wide as high, decreasing in size slightly upward. Pinnulæ wanting. The ambulacral furrow is covered by small alternating pieces, about five to each arm-joint.

Column round, small.

The unsymmetrical form of the calyx, produced by the protuberance of the posterior side; the peculiar position and small size of the right posterior radial, and the large anal plate in line with the four larger radials, are the most remarkable features of this genus, and those by which it is easily recognized. The small radial evidently corresponds to the upper half of the compound plate in *Dendrocrinus*, while the lower half, which is here apparently absent, is perhaps represented in a portion of the large undivided anal plate.

Geological position.—Lower Silurian, and so far found only in America.

The following species have been discovered:—

1856 *Hyboocrinus conicus* Billings (type of the genus), (Geol. Surv. Canada, p. 274; also Decade IV. p. 29, pl. 2, fig. 2 a, b. Trenton limestone. Ottawa, Canada.

1856. *Hyboer. tumidus* Billings. Geol. Surv. Canada, p. 275; also Decade IV. p. 28, pl. 2, figs. 1 a-c. Trenton limestone. Ottawa, Canada.
1859. *Hyboer. pristinus* Billings. Geol. Surv. Canada, Decade IV. p. 28, pl. 1, fig. 2 a. Chazy limestone. Montreal, Canada.

5. **DENDROCRINUS** Hall.

Diagram Pl. 16, Fig. 5.)

1852. *Dendrocrinus* Hall. Geol. Rep. N. Y., vol. ii. p. 193.
1859. *Dendrocrinus* Billings. Geol. Surv. Canada. Decade IV. p. 35.
1878. *Dendrocrinus* (subgenus of *Peterocrinus*) Meek. Geol. Surv. Ohio, Pal., vol. i. p. 20.

A. Typical form.

General form of the crinoid elongate and slender. Calyx obconical, higher than wide, unsymmetrical.

Underbasals five, similar in form, scarcely of medium size, but extending beyond the column. Basals five, the largest plates in the calyx; four of them equal, hexagonal, the fifth or posterior one heptagonal, truncate above for the support of a large anal plate. Radials alternating with the basals all around, simple in four of the rays, pentagonal and of about equal size. The right posterior radial is compound, divided by a horizontal suture into two halves, which, taken together, have about the form of the simple plates, only slightly longer. Brachials two to five, some long and narrow, and others short and wide. Anals one, subquadrangular.

Arms long, branching; ambulacral furrow deep. Pinnulae wanting.

Lower jaw known. Ventral sac strongly developed, composed of

suture (which becomes oblique in *Homocrinus*), in *Poteriocrinus* it supports a third anal plate, and by pushing the right radial to one side assumes its oblique position which it maintains throughout all genera of the *Poteriocrinus* group; while in the *Cyathocrinus* group the compound radial becomes modified into a single plate.

Geological position.—Lower Silurian with the exception of a single species from the Niagara group.

The following species are known:—

1854. *Dendrocrinus acutidactylus* Billings. Geol. Surv. Can., p. 266; also Dec. iv. p. 37, pl. 3, fig. 2 a, b. Trenton limest. Montreal, Canada.
- 1843. *Dendrocr. alternatus* Hall. (*Poteriocr. alternatus*.) Geol. Rep. N. Y., vol. i. p. 83, pl. 28, figs. 1 a–f. Trenton limest. Middlerille, New York.
- 1870. *Dendrocr. angustatus* Meek & Worth. (*Homocr. angustatus*.) Proc. Acad. Nat. Sci. Phil., p. 30; also Geol. Rep. Ill., vol. vi. p. 492, pl. 23, fig. 8. Hudson River Gr. Illinois.
1866. *Dendrocr. caduceus* Hall. (*Poteriocr. (Dendrocr.) caduceus*.) Descr. New sp. Crin. etc., p. 3; also 24th Rep. N. Y. St. Cab. Nat. Hist. 1872, p. 208, pl. 5, figs. 7, 8; also Geol. Surv. Ohio, Pal., vol. i. p. 26, pl. 3, figs. 1 a, b, c. Hudson River Gr. Lebanon, Ohio.
1871. *Dendrocr. Casel* Meek. (*Poteriocr. (Dendrocr.) Casel*.) Am. Jour. Sci., vol. ii (3d ser.) p. 295; also Geol. Rep. Ohio, Pal., vol. i. p. 28, pl. 3, figs. 2 a, b, c. Hudson River Gr. Richmond, Ind.
1872. *Dendrocr. Cincinnatiensis* Meek. (*Poteriocr. (Dendrocr.) Cincinnatiensis*.) Proc. Acad. Nat. Sci. Phil., p. 312; also Geol. Surv. Ohio, Pal., vol. i. p. 29, pl. 3, figs. 5 a, b. Hudson River Gr. Cincinnati, O.
1856. *Dendrocr. conjugans* Billings. Geol. Surv. Can., p. 265; also Decade iv. p. 41, pl. 4, figs. 1 a, b, and 2 a, b. Trenton limest. Ottawa, Canada.
1859. *Dendrocr. cylindricus* Billings. Geol. Surv. Can., Dec. iv. p. 44, pl. 3, figs. 8 a, b. Trenton limest. Montreal, Canada.
1873. *Dendrocr. Dyeri* Meek. (*Poteriocr. (Dendrocr.) Dyeri*.) Proc. Acad. Nat. Sci. Phil., p. 314; Geol. Surv. Ohio, Pal., vol. i. p. 24, pl. 3, figs. 3 a, b. Hudson Riv Gr. Cincinnati, O.
1843. *Dendrocr. gracilis* Hall. (*Poteriocr. gracilis* Hall, not McCoy.) Geol. Rep. N. Y., vol. i. p. 84, pl. 28, figs. 2 a–d. Trenton limest. Middleville, N. Y. Syn. *Poteriocr. subgracilis* d'Orbigny
1856. *Dendrocr. gregarius* Billings. Geol. Surv. Can., p. 265; also Dec. iv. p. 36, pl. 3, figs. 1 a, b, c. Trenton limest. Ottawa, Canada.
1856. *Dendrocr. Jewetti* Billings. Geol. Surv. Can., Dec. iv. p. 43. Trenton limest. Bay of Quinte, Canada
1856. *Dendrocr. humilis* Billings. Geol. Surv. Can., p. 270; Dec. iv. p. 39, pl. 3, fig. 4. Trenton limest. Ottawa, Can
1856. *Dendrocr. latibrachiatas* Billings. Geol. Surv. Can., p. 270; also Dec. iv. p. 39, pl. 3, figs. 5 a, b, c. Hudson River Gr. Charleston Point, Anticosti
1853. *Dendrocr. longidactylus* Hall (Type of the genus). Geol. Rep. N. Y., vol. ii. p. 193, pl. 43, figs. 1 a–k; also pl. 42, figs. 7, a, b. Niagara Gr. Lockport, N. Y.

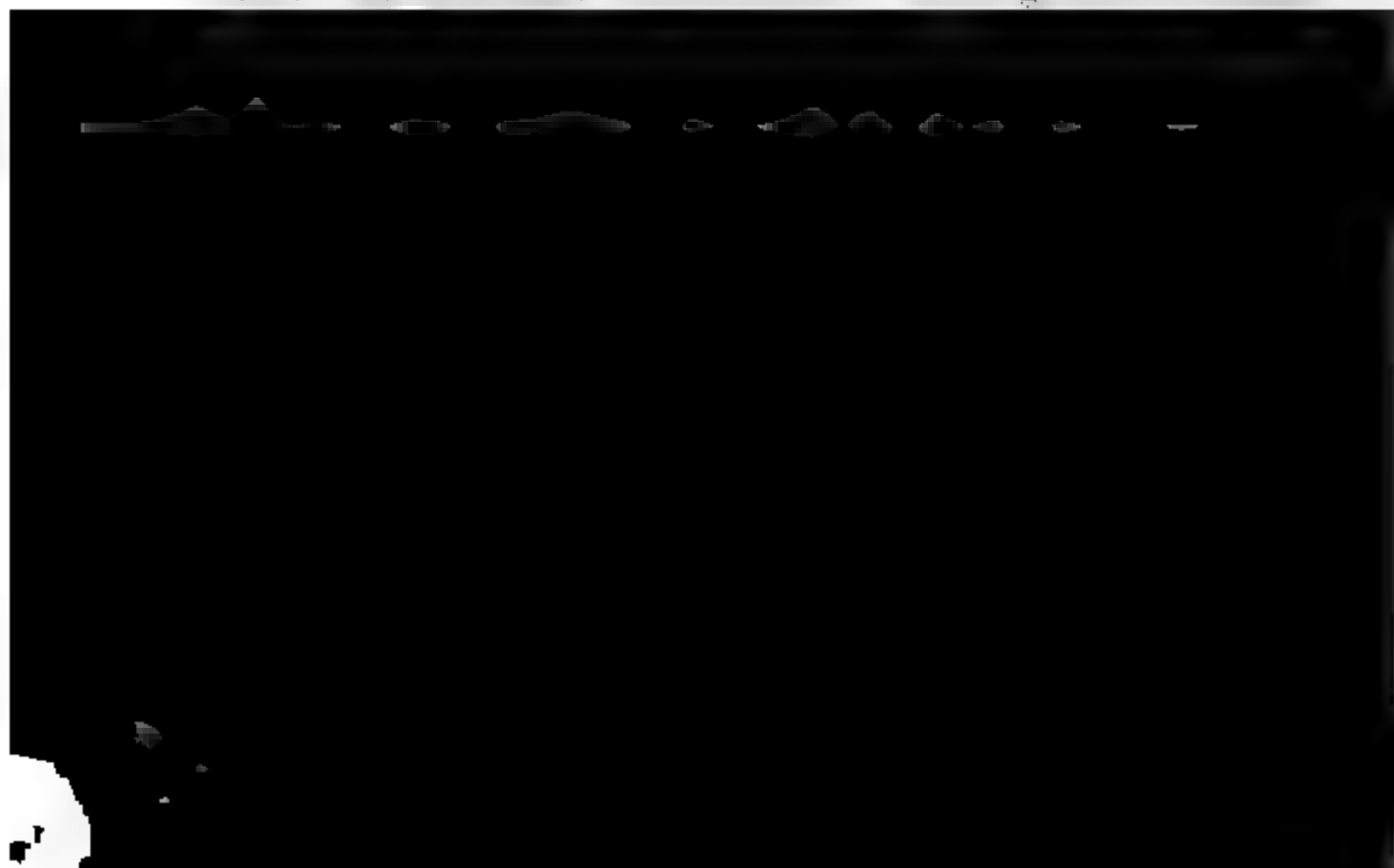
1868. (?) *Dendrocr. Oswegoensis* Meek & Worth. Geol. Rep. Ill., vol. iii. pl. 4, fig. 4. (The specimen is too imperfect for identification.) Hudson River Gr. Oswego, Ill.
- *1867. *Dendrocr. polydactylus* Shumard. (*Homocrinus polydactylus*) Trans. Acad. Sci. St. Louis, vol. i. p. 78, pl. 1, fig. 6; also Geol. Surv. Ohio Pal., vol. i. p. 22, pl. 3, fig. 9. Hudson River Gr. Richmond, Ind.
- *1872. *Dendrocr. posticus* Hall (*Poteriocer. posticus*.) 24th Rep. N. Y. St. Cab. Nat. Hist., p. 209, pl. 5, figs. 5 and 6. *Poteriocer. (Dendrocr.) posticus*, Meek. Geol. Surv. Ohio, Pal., vol. i. p. 22, pl. 3, figs. 4 a, b, c. Hudson Riv. Gr. Cincinnati, O.
1866. *Dendrocr. proboscidiatus* Billings. Geol. Surv. Can., p. 267; also Dec. iv. p. 38, pl. 3, figs. 3 a-c. Trenton limest. Montreal, Can.
1866. *Dendrocr. rusticus* Billings. Geol. Surv. Can., p. 270; also Dec. iv. p. 41, pl. 3, figs. 7 a, b. Trenton limest. Ottawa, Can.
1866. *Dendrocr. similis* Billings. Geol. Surv. Can., p. 267; also Dec. iv. p. 40. Trenton limest. Ottawa, Canada.
1866. *Dendrocr. tener* Billings. Catalogue Foss. of Anticosti Hudson Riv. Gr. Anticosti. Miller's Cat. (We have no means of comparison.)

B. Subgenus *HOMOCRINUS* Hall.

(Diagram Pl. 15, Fig. 6.)

1852. Geol. Rep. N. Y., vol. ii. p. 185.

The following is Hall's generic description of *Homocrinus*: "Crinoides having the calyces composed of three series of simple plates, each series consisting of five plates, sometimes one or more irregular plates intercalated between the scapular or third series of plates on one side; arms proceeding from the summit of the third series of plates, without tentacles." And he says further: "The Crinoids constituting this genus have been referred to *Poteriocrinus* and *Cyathocrinus*, the structure of which genera are some-



both under *Poteriocrinus*. In 1861, however, he described two new species under *Homocrinus*, from good specimens. They are not *Poteriocrinus*, for they have no pinnule, nor *Cyathocrinus*, for they have an extra intercalated plate above the basals; nor *Dendrocrinus* for that plate is not radial; but their affinities are the closest with the latter, with which they agree in all principal characters. We therefore regard *Homocrinus* as a subgenus under *Dendrocrinus*, and propose the following description, with *Homocrinus scoparius* Hall as type:—

General form and arrangement of plates like in the typical *Dendrocrinus*, except at the posterior side where the lower portion of the compound plate is pushed slightly to the rear, thereby becoming a regular anal plate or support for the ventral sac. Hence in *Homocrinus* only the upper portion of the compound plate is a radial, and there are two anal plates, one subquadrangular, between the posterior radials, and supported on the truncated basal; and a smaller one resting obliquely between two basals, the right radial and the other anal plate.

The underbasals are perhaps proportionally larger than in *Dendrocrinus*. The arms have no pinnule, and this, together with the different arrangement of the anal plates forms the best distinction from *Poteriocrinus*. The ventral sac is without mesial ridge or lateral costae. Column, so far as observed, round.

Geological position, etc.—Upper Silurian in America. In Europe it has been found in the Devonian.

Six species are known.—

- 1852 *Homocrinus cylindricus* Hall. Geol. Rep. N. Y. vol. II. p. 186, pl. 41, figs 2 a, b. Hall, 1859 *Poteriocr. cylindricus*. Correct List of N. Y. Foss. Niagara Gr. Lockport, N. Y.

The specimens are too imperfect for identification.

- 1844 *Homocr. fusiformis* Roemer. Rhein. Ueberrausg. p. 61, pl. 3, fig. 2. Schuch. *Bactocrinitis fusiformis*, Steininger & Geogr. Brocher der Eifel, p. 26. Muller *Poteriocrinus fusiformis*, Neue Kellen d. R. d. Kalk., p. 256, pl. 7, fig. 2. also Schuch. Ebnend. d. d. Kalk., p. 43, pl. 5, fig. 1 a-g. Devonian. Eifel, Germany.

- 1844 *Homocr. nanus* Roemer. (*Poteriocrinus nanus*.) Palaeontographia, by Wm. Dunker p. 131, pl. 29, figs 2, 3. Devonian. Bundenbach, Germany.

- 1852 *Homocr. parvus* Hall. Geol. Rep. N. Y., vol. II. p. 185, pl. 41, figs 1 a, b. *Poteriocrinus parvus* Hall, 1859. Corr. List N. Y. Foss. Niagara Gr. Lockport, N. Y.

(Probably a very young individual of some other species.)

1861. *Hemocr. proboscidioides* Hall. Geol. Rep. N. Y., vol. III. p. 38, pl. 82, figs. 24, 25. Oriskany sandstone. Cumberland, Md.
 1861. *Hemocr. scaparius* Hall (Type of the genus) Geol. Rep. N. Y., vol. III. p. 102 pl. I. figs. 1-9. Lower Helderberg. Litchfield, N. Y.

6. CYATHOCRINUS Miller.

(Diagram Pl. 16, Fig. 8.)

1821. Miller. A History of the Crinoidea, p. 83.
 1834. Agassiz. Mém. de la Soc. de Neuch., vol. I.
 1848. Austin. Monogr. Rec. and Foss. Crin., p. 59.
 1853. De Koninck and Lehon. Rech. s. les Crin. Carb. Belgique, p. 81.
 1858. Hall. Geol. Surv. Iowa, vol. I. pt. II. p. 622.
 1866. Meek and Worthen. Geol. Rep. Ill., vol. II. p. 175.
 1873. Meek and Worthen. Geol. Rep. Ill., vol. V. p. 400.
 1877. Wachsmuth. Am. Journ. Sci. (August No.), p. 120.
 1878. Wachsm. and Springer. Proc. Acad. Nat. Sci. Phila., p. 256.
 Syn. 1859. *Palaeocrinus* Billings. Geol. Rep. Can., Decade IV. p. 24.
 Syn. *Sphaerocrinus* Roemer. 1851. Beiträge, z. foss. fauna n. Rhein, p. 18.

In the Thesaurus Devonico-Carboniferus, Dr. Bigsby calls *Cyathocrinus* very appropriately "a genus full of errors." This unfortunate condition is largely due to the confusion existing among Miller's typical species, which embrace an assemblage of very distinct types. It seems even doubtful whether any of his species can be properly ranked within the genus, and this would naturally suggest the question whether *Cyathocrinus*, as Roemer has suggested, ought not to be given up altogether. We are of opinion, however, that the genus ought to stand, and that it can be so amended as to include certain forms of Crinoids which have been

which Goldfuss made the type of *Crotalocrinus*. 4. *C. quinquangularis*, which has been conceded to be a *Poteriocrinus*. As a proof how indefinite was Miller's conception of the genus, it may be noted that three of the four species are of distinct families, while he himself places *Poteriocrinus* among the Semiarticulata, and *Cyathocrinus* among the Inarticulata.

C. planus is, therefore, the only species that need be considered with reference to *Cyathocrinus*. The "pelvis" has the typical saucer shape, with a subpentangular perforation. There are five "costals," four of them hexagonal, the fifth with a truncated superior margin; "scapula" of similar form to those in *Poteriocrinus*, having also a horseshoe-like impression, with a transverse perforated ridge for the reception of the first arm joint (brachial), and which is succeeded by a cuneiform bifurcating plate. The arms (or hands of Miller) bifurcate several times, and there are six fingers to each division of the ray, which are all tentaculated on alternate sides. Here again is mentioned a single (anal) plate interposed between the radials or "scapulae," and this plate is placed upon the truncate costal (basal). The description applies well generically to a large number of species which have been referred to *Cyathocrinus*, differing, however, in the pinnulate (tentaculated) arms. Not one of those species has ever been found with pinnule, though we have examined with reference to this point a large number of species, and some most perfect specimens, in which the covering of the ambulacral furrow is beautifully exposed all along the arm, and in which it seems certain that if they had been provided with pinnulae, these organs would have been preserved. A similar covering has been found, with slight modification, in three or four other genera of the *Cyathocrinidae*, but never in species with pinnulae, and this suggests the idea that they may not exist in those genera. We therefore consider the presence or absence of pinnulae of generic importance, and do not hesitate to say that if Miller's *Cyathocrinus planus* had pinnulae, it cannot be classified with species in which these organs are wanting, and we also feel assured, from analogy, that if this was the case in *C. planus*, it will be found to possess more than one anal plate in the calyx, and prove to be a true *Poteriocrinus*.

Miller figures three specimens of this species. Fig. 1 represents an entire specimen, with a piece of column and perfect arms; the arms branch off from the second brachial, and are

long, composed of wedge-form plates, which give off on alternate sides a row of strong pinnulae, such as are found in *Poteriocrinus*. The specimen shows one side and partly the anterior of the body, for the ray at the extreme right has apparently more brachials than the other four, which is a very common occurrence in *Poteriocrinus*. Anal plates are not visible in the specimen, being probably imbedded in the rock. The second specimen, Fig. 28, is not sufficiently intelligible. The posterior side is shown, but the arrangement of the anal portion is so obscure that it gives no information whatever. The form of the calyx is like *Poteriocrinus*, subconical, and resembling Fig. 1.

The third specimen, Figs. 29 and 30, from the Ashmolean collection of Oxford, gives only the calyx, but this is sufficient to show that it is an entirely different form from that represented by Figs. 1 and 28. The position of the plates, the form of the calyx with strongly convex sides, the peculiar articulating facet of the first radials, their proportions, and the arrangement of the anal area, agree in every respect with Miller's generic diagram,¹ and with those species which we have mentioned as having no pinnulae. On the other hand, the first two figures in the subconical form of the calyx, in the disposition and form of the plates, in having two additional brachials in the anterior ray, in the presence of pinnulae, closely resemble *Poteriocrinus*. This has induced us to consider the Ashmolean specimen alone² to be *Cyathocrinus planus* and the type of the genus, and we propose an amendment of the generic formula so as to admit only those species that are without pinnulae, making the latter one of the best distinctions

between this genus and *Poteriocrinus*. The truncated posterior basal, the number and disposition of the anal plates, and the regular alternate arrangement of basals and radials are also excellent characters by which the two genera may be easily distinguished, but not the construction of the vault, nor the presence or absence of a separate buccal aperture, as Austin and De Koninck suggested; for both genera have a similar low vault with a single aperture, and in both types the ventral sac is lateral, strong, and upright, instead of extending from the entire summit like an enormous proboscis, as it has been described by several authors. De Koninck and Lehon give the number of anal plates at two to six, but there is really but one plate that can be regarded as such, all succeeding ones forming a part of the ventral sac.

Hall, in order to admit into *Cyathocrinus* such types as were afterwards separated under *Barycrinus*, mentions in the Iowa Report that there sometimes occurs in the anal area a rather small intercalated plate; but this, though having a similar position, cannot be considered identical with the lower anal plate of *Poteriocrinus*. *Barycrinus* has been very generally accepted as a genus, and as the plate in question has only been observed in species of that type, it need no longer be considered in this connection.

Angelin, in the *Iconographia Crinoideorum*, p. 22, mentions the presence in *Cyathocrinus* of small pinnule. We have already noticed this point in the introductory remarks, and think we have proved that the two alternate rows of plates, there called pinnule, are merely plates which cover the ambulacral groove in the arms, and though they are, in our opinion, the homologues of the pinnule, they are too rudimentary to be ranked as such. The covering in *Cyathocrinus longimanus* Angl., from the Silurian, consists of two rows of five successive plates each, one row being given off from the right, the other from the left side of the furrow and perfectly covering it. In *Cyathocr. lowensis* O. & Shum., from the Subcarboniferous, there have been observed only two successive plates arranged in the same manner. If it could be shown that this structure were constant in all Silurian species of *Cyathocrinus*, we should feel disposed to separate them from their subcarboniferous representatives, at least subgenerically, since in the former the arm-joints are comparatively shorter, the ventral tube stronger, and there is besides a peculiar difference in the general habitus of the two which is not easily expressed.

Sphærocrinus Roemer is founded upon *Cyathocrinus geometricus* Goldfuss, and it has all the characters of *Cyathocrinus*, not only in the construction of the calyx, but also of the vault, and we find a contraction of the body in the arm regions in the majority of its species.

Palæocrinus Billings is not distinct from *Cyathocrinus*. The construction of the calyx is identical, and the five calycinal grooves radiating from the centre of the abdominal surface, which, according to Billings, form the principal distinction, are identical with the ambulacral grooves passing here as there over the sutures of the oral plates. *Cyathocrinus*, especially in its Lower Silurian form, and when deprived of the arms, bears the closest relation to some forms of the Blastoids on one side, and the Pentacrinoid larva on the other. We propose the following:—

Revised Generic Diagnosis: General form of the body with arms, elongate; calyx cyathiform, usually with convex sides, incurving toward the upper margin, and, therefore, subglobose in general outline; symmetry bilateral.

Underbasals five, moderately large, of equal size, either spread out horizontally or with a slight upward curvature. Basals large, regularly alternating with the radials, with acute upper angles, except the posterior one which is truncate for the support of a single anal plate. Radials one by five, as large or larger than the basals, incurving toward the vault. Articulating facet rarely occupying more than one-half the width of the plate—often less than one-third—and one fourth to one-third its height. It is on the exterior of the plate, circular or elliptic in form, and provided either with a small

the pinnulæ and in the structure of the ambulacral groove, which, instead of those appendages, is provided with two rows of from two to five successive movable plates, alternately arranged on opposite sides, by means of which the furrow could be opened to the surrounding element, or shut off from it.

Anal plate one, resting upon the superior edge of the truncated basal and between two radials. None of the succeeding plates in the series are embraced in the calyx; they are much smaller and form a part of the ventral sac.

The vault is composed of five large oral plates, joining laterally, which fit in between the inflected margins of the two radial plates, leaving in the oral centre an open space, which in perfect specimens is completely covered by the apical dome plates. The food groove and ambulacral canal are also arched over solidly by two rows of alternate plates which connect with the movable covering of the arm furrow. The ventral sac extends to about one-half the height of the arms, and is composed of a large number of small plates not so regularly arranged as in *Poteriocrinus*. Its communication with the main body internally is maintained by means of a passage pierced through the posterior oral plate. The sac is stronger in the Silurian species, and in them only have pores and slits been observed.

Column round, with alternate larger and smaller joints in its upper portion; central passage scarcely of medium size.

Geological position, etc.—The genus existed in the Lower Silurian, was well represented in the Upper Silurian, and attained its greatest abundance in the Subcarboniferous. Beyond the age of the Keokuk limestone no trace of it has been discovered, and toward the close of that epoch the general aspect of the species underwent a marked change, the later species being large, and the arms, which before were delicate, became very robust at the bases. (See Wachsm. & Spr., Proc. Acad. Nat. Sci. Phila., 1878, p. 257.) According to Murchison and others, *Cyathocrinus* is represented in the Permian, but nothing has been discovered upon which to base this opinion beyond the fragments of columns, which afford no reliable proof. So far as ascertained there are 4 species from the Lower, 19 from the Upper Silurian; a single one from the Devonian; 28 from the Subcarboniferous, making in all 53 species, of which 27 have been found in Europe, and 26 in America.

1878. *Cyathocrinus acinotubus* Angelin. Iconogr. Crin. Suec., p. 23, pl. 20, fig. 3. Upper Silur. Gotland, Sweden.
1856. *Cyathocr. angulatus*, Billings. (*Palaeocrinus angulatus*.) Geol. Surv. Can., p. 269; also Dec. iv. pl. 3, figs. 6 a, b. Trenton limest. Ottawa, Canada.
1878. *Cyathocr. alutaceus* Angelin. Iconogr. Crin. Suec., p. 23, pl. 4, fig. 6, and pl. 23, figs. 10, 11. Upper Silur. Gotland, Sweden.
1865. *Cyathocr. arboreus*, Meek & Worth. Proc. Acad. Nat. Sci. Phil., p. 160; also Geol. Rep. Ill., vol. iii. p. 520. Keokuk limest. Subcarb. Crawfordsville, Indiana.
- *1861. *Cyathocr. Barrii* Hall. (*Potarioer. Barrii*.) Desc. New Pal. Crin., p. 6; also Boot. Jour. Nat. Hist., p. 303. Lower Burlington limest. Subcarb. Burlington, Iowa.
1878. *Cyathocr. barydaetylus* Waehsmuth & Springer. Proc. Acad. Nat. Sci. Phil., p. 257, pl. 2, fig. 5. Upper Burlington Fishbed. Subcarb. Burlington, Iowa.
1836. *Cyathocr. bursa* Phillips. Geol. Yorksh., vol. ii. p. 206, pl. 3, fig. 39; 1843, Austin, Mon. Rec. & Foss. Crin., p. 63, pl. 7, fig. 7 a. Subcarboniferous. Bolland, England.
1836. *Cyathocr. calcaratus* Phillips. Geol. Yorksh., p. 206, pl. 3, fig. 35; also Austin, 1843, Rec. & Foss. Crin., p. 63, pl. 8, fig. 2 a-c. Subcarbon. England.
1839. *Cyathocr. capillaris* Phillips. Murch. Silur. Syst., p. 671, pl. 17, fig. 2. Upper Silur. Dudley, England.
1836. *Cyathocr. conicus* Phillips. Geol. Yorksh., vol. ii. pt. ii. p. 206, pl. 3, fig. 27; also Austin, 1843, Rec. & Foss. Crin., p. 64, pl. 8, figs. 1 a, b. Subcarb. Bolland, England.
1868. *Cyathocr. cora* Hall. 18th Rep. N. Y. St. Cab. Nat. Hist., p. 324, pl. 11, figs. 13, 14. Niag. group, U. Silur. Racine, Wisconsin.
1836. *Cyathocr. distortus* Gilbert. Phillips' Geol. Yorksh., vol. ii. p. 206, pl. 3, fig. 34. Subcarb. Bolland, England.
1878. *Cyathocr. distensus* Angl. Iconogr. Crin. Suec., p. 23, pl. 3, figs. 6, 6 a. Upper Silur. Gotland, Sweden.
- *1843. *Cyathocr. Dudleyensis* Angl. (*Potarioer. Dudleyensis*.) Upper Silur.

p. 390, pl. 25, fig. 14; Müller, *Poteriocer. geometricus*, Neue Echinod., d. Eifel. Kalkes, p. 250, pl. 2, figs. 4-7, and pl. 4, figs. 1-3. Schultze, Mon. Echinod., Eifel. Kalkes. p. 51, pl. 5, fig. 6 a to l. Schultze recognizes the following varieties: var., *typus*, pl. 5, fig. 6 a, b; var., *reticularis*, pl. 5, fig. 6 f, i; var., *ornata*, fig. 6 l; var., *ornata tuberculata*, fig. 6 k; var., *concentrica*. Devonian. Eifel, Germany.

Syn. *Poteriocrinus hemisphaericus*, Müller. Monatsber. d. Berl. Acad. d. Wissensch. 1856, p. 354.

Syn. *Sphaerocr. stellatus*, Schnur. Steininger's geognost. Besch. d. Eifel. p. 38.

. *Cyathocr. Gilesi* Wachsmuth & Springer. Proc. Acad. Nat. Sci. Phil., p. 259. Fishbed, Upper Burl. limest. Subcarb. Burlington, Iowa.

. *Cyathocr. glabror* Angelin. Iconogr. Crin. Suec., p. 23, pl. 23, figs. 12, 13. Upper Silur. Gotland, Sweden.

. *Cyathocr. goniodactylus* Phillips. Murch. Silur Syst., p. 671, pl. 17, fig. 1. Upper Silur. Dudley, England.

9. *Cyathocr. Harrodi* n. sp. (For description see note below.)

Cyathocr. incipiens Hall. Desc. New Pal. Crin., p. 5; Bost. Jour. Nat. Hist. 1861, p. 296. Upper Burl. limest. Subcarb. Burlington, Iowa.

Cyathocr. incurvatus Angl. Iconogr. Crin. Suec., p. 23, pl. 24, fig. 1. Upper Silur. Gotland.

Cyathocr. Iowensis Owen & Shumard. Journ. Acad. Nat. Sci. Phil. (2d ser.) vol. ii.; Geol. Surv. Wisc. Iowa and Minn., p. 591, pl. 5 A, figs. 11 a, b, c. Upper and Lower Burl. limest. Subcarb. Burlington, Iowa.

Syn. *C. divaricatus* Hall, 1858. Geol. Rep. Iowa, vol. i. pt. ii. p. 554, pl. 9, fig. 5. (Young specimen.)

Syn. *C. malvacens* Hall, 1858. Geol. Rep. Iowa, vol. i. pt. ii. p. 554, pl. 9, fig. 4 a, b. (Depressed specimen.)

Syn. *C. viminalis* Hall, 1861. Desc. New Pal. Crin., p. 5; Bost. Jour. Nat. Hist., p. 299. (See Wachsm. & Spr., Proc. Acad. Nat. Sci. Phil. 1877, p. 256.)

Cyathocr. lamellosus White. Bost. Journ. Nat. Hist., p. 504. Upper Burl. limest. Subcarb. Burlington, Iowa.

Cyathocr. laevis Angelin. Iconogr. Crin. Suec., p. 23, pl. 26, figs. 2, 3. Upper Silur. Gotland, Sweden.

Cyathocr. longimanus Angelin. Iconogr. Crin. Suec., p. 22, pl. 20, figs. 4, 6, 7, pl. 26, figs. 4, 5. Upper Silur. Gotland, Sweden.

(?) *Cyathocr. mammillaris* Phillips. Geol. Yorksh., vol. ii. p. 206, pl. 3, fig. 28; Austin, 1843, Rec. & Foss. Crin. p. 64, pl. 7, fig. 8 a, b; De Koninck & Lehon, 1863, Recherches s. l. Crin. Carb. Belg., p. 82, pl. 1, fig. 4. Subcarboniferous. Bolland, England, and Visé, Belgium.

Cyathocr. monilifer Angelin. Iconogr. Crin. Suec., p. 23, pl. 21, figs. 15, 15 a. Upper Silur. Gotland, Sweden.

Cyathocr. multibrachiatus Lyon & Cassiday. Am. Jour. Sci., vol. 28. Keokuk limest. Subcarb. Crawfordsville, Indiana.

Cyathocr. muticus Angelin. Iconogr. Crin. Suec., p. 23, pl. 21, figs. 22, 23. Upper Silur. Gotland, Sweden.

(?) *Cyathocr. ornatus* Phillips. Geol. Yorksh., pt. ii. p. 206, pl. 4, figs. 36, 37. Subcarboniferous. Bolland, England.

1861. *Cyathocr. parvibrachiatum* Hall. Desc. New. Pal. Crin., p. 6; Best Journ. Nat. Hist., p. 294. Keokuk limestone. Subcarb. Keokuk, Iowa.
1821. *Cyathocr. planus* Miller. A History of the Crinoides, p. 65, figs. 29, 30 (not figs. 1 and 28); Austin, 1843; Rec. & Foss. Crin. p. 59, pl. 7, figs. 4 a-e. Subcarboniferous. Near Bristol, England.
1863. (?) *Cyathocr. polyzo* Hall. New sp. foss. from Niagara Gr. p. 5; and figured without description, 28th Rep. N. Y. St. Cab. Nat. Hist., pl. 15, figs. 16-17. Niagara limestone. Upper Silur. Waldron, Indiana. (This is evidently not *Cyathocrinus*, but its generic relations cannot be ascertained from the material which has been discovered.)
1870. *Cyathocr. poterium* Meek & Worthen. Proc. Acad. Nat. Sci. Phil., p. 24; Geol. Rep. Ill., vol. v. p. 499, pl. 12, fig. 4. Keokuk limestone. Subcarb. Crawfordville, Indiana.
- *1859. *Cyathocr. pulchellus* Billings. (*Palaeocr. pulchellus*.) Geol. Surv. Can., Dec. iv. p. 46. Trenton limestone. L. Silur. Ottawa, Can.
1878. *Cyathocr. ramosus* Angelin. Iconogr. Crin. Suec., p. 23, pl. 30, figs. 1-3. Upper Silur. Gotland, Sweden.
1856. (?) *Cyathocr. radiatus* Eichwald. (*Aplocrinus radiatus*.) Bull. Soc. des Nat. de Moscou, p. 115; Lethaea Rossica, p. 592, pl. 31, figs. 50 a-f. Carboniferous. Near Moscow, Russia. (Perhaps *Poteriocrinus*—the figures not sufficiently intelligible.)
- *1859. *Cyathocr. rhombiferus* Billings. (*Palaeocrinus rhombiferus*.) Geol. Surv. Can., Dec. iv. p. 45. Trenton limestone. L. Silur. Ottawa, Can.
1862. *Cyathocr. rigidus* White. Proc. Best Soc. Nat. Hist., p. 8. Lower Burlington limestone. Subcarb. Burlington, Iowa.
1858. *Cyathocr. rotundatus* Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 555, pl. 9, figs. 7 a, b. Upper Burlington limestone. Subcarb. Burlington, Iowa.
1826. *Cyathocr. rugosus* Goldfuss. Subcarboniferous. Saxony.
1866. *Cyathocr. saffordi* Meek & Worthen. Proc. Acad. Nat. Sci. Phil., p. 371; Geol. Rep. Ill., vol. ii. p. 236, pl. 17, figs. 5 a, b. Keokuk limestone. Subcarb. Tennessee.
- *1859. *Cyathocr. striatus* Billings. (*Palaeocr. striatus*.) Geol. Surv. Can., Dec. iv. p. 25, pl. i. fig. 5 a, b. Chazy limestone. Montreal, Can.
1878. *Cyathocr. striolatus* Angelin. Iconogr. Crin. Suec., p. 23, pl. 19, fig. 9

gular, the two lower sides making about a right angle. Articulating scar occupying about one-third the width of the plate, somewhat concave, and facing obliquely outward. Brachials varying from two to four or more in the rays, wider than high, rounded on the exterior, the upper one giving rise to two main arms, each of which branches three times.

Arms long, decreasing in width at each bifurcation, very delicate at the tips, the arm-joints increasing in length upward. Ventral furrow covered by two alternating rows of from two to three pieces. Anal plate small.

Surface of plates ornamented by strong radiating ridges, two to each radial, which connect with those of the two adjacent basals. They are most prominent on the latter, where they converge toward the middle into a node which points downward. These nodes, and their downward direction, give to the specimen an appearance very like *Ollacrinus*. Underbasals smooth.

Column small, round, composed of thin smooth joints, alternating in size; central perforation round.

This species is most nearly related to *C. lamellosus* White, of the Upper Burlington limestone, from which it differs in the number and form of the arms, which in our species are rounded, instead of sharply ridged on the back; in the surface markings of the calyx, and in the smooth column—that of *C. lamellosus* being beautifully sculptured.

The specific name is in honor of Dr. Harrod, of Canton, Ind., to whom we are indebted for the discovery and use of specimens.

Position and Locality. Keokuk limestone (Crawfordsville Division), Canton, Indiana, Collections of C. Wachsmuth and Dr. Harrod.

7 LECYTHOCRINUS Zittel (not Joh. Müller).

1878 *Lecythocrinus* Müller. Monatsber. der Berl. Akad., p. 196 (based upon an anomalous specimen).

1886 *Tarocrinus* Schultze. Echinod. d. Eil. Kalkes, p. 30.

1879 *Lecythocrinus* Zittel. Handb. d. Petrefactenkunde (now in press).

Under this generic name, Johannes Müller described a species which, according to Schultze, was an abnormal specimen of his *Tarocrinus brevis*. In the original specimen, which is figured by Schultze, Mon. Echinod. d. Eil. Kalkes, pl. 1, figs. 1 a-e, there are six radials and seven main arms, besides other irregularities in the calyx, plainly indicating some disturbance in the natural growth of the animal.

In the Am. Journ. Sci., Sept. 1877, one of us expressed a doubt as to *T. brevis* being a *Tarocrinus*, and we have since become convinced that its nearest affinities are with *Cyathocrinus* and *Glossocrinus*, from both of which it differs in the construction of the column, and in the small size of its underbasals. If the species possesses five underbasals, as we believe, it ought to be placed

subgenerically under *Cyathocrinus*; if it has but three, as Schultze supposed (they have not been observed), it should be similarly ranked under *Gissocrinus*, but at all events under the *Cyathocrinidæ*.

Generic Diagnosis.—General form of the calyx cyathiform; symmetry bilateral.

Underbasals very small, entirely covered by the column, their number not ascertained. Basals five, four of them equal, the fifth or posterior one with the upper side truncate. Radials large, alternating with the basals; articulating faces concave, occupying one-half to two-thirds the width of the plate. Brachials two to four or more, their number varying in the different rays, as well as in different individuals. They are very short, the upper one supporting on each sloping side two main arms, which divide on the second or third plate, each division branching several times again.

Arms long, composed of simple joints, and provided with a dorsal canal' and a deep ambulacral furrow. No pinnulæ.

Anal plate one, constructed as in *Cyathocrinus* and resting upon the truncate posterior basal. Ventral sac in form of a long tube, constructed of numerous very regular hexagonal plates of equal height, longitudinally arranged in alternately wider and narrower rows.

The column, which forms the best generic distinction, is obtusely quadrangular, with slightly concave sides, and is composed of very narrow joints of equal size, which are penetrated by a large central and four smaller accessory canals, situated within the joints of the

triose above the arm bases. Calyx low, neatly ornamented by radiating striae; symmetry bilateral.

Underbasals three instead of five, two of them equal and twice as large as the third; the smaller one placed anteriorly, the sutures of the two larger directed to the rear. The plates are so arranged that a bisection of the latter two produces five equal pieces regularly alternating with the succeeding ring of basals. Basals large, four of them pentagonal or hexagonal with sharp upper angles, the fifth longer, hexagonal, truncate above. Radials semilunate, larger than the basals, wider than long; articulating facet concave and occupying about one-half the width of the plate. The brachials consist either of a single bifurcating plate, which is wider than long, pentangular; or in some species of two smaller plates which combined have about the form and proportions of the single one.

Arms long, bifurcating, branches very numerous and of almost uniform thickness throughout their length. The divisions take place at regular intervals, but only toward the inner side of the ray, the outer or main arms remaining straight; the inner arms or branches remain simple or in some cases subdivide once or twice. The first bifurcation of the main arms takes place upon the first or second plate above the brachials, the next and all succeeding bifurcations from each first, second, or fourth plate, according to species. Arm-joints distinctly rounded on the exterior, with parallel sutures, rather higher than wide, the upper margin generally projecting into a band inclosing the lower part of the next plate. The axillary or bifurcating plates the largest, with a sharp angular process at their sides toward the upper margin. No pinnules. Arm furrows covered by two rows of alternate plates which stand out prominently forming an elevated arch.

Anal plate one, which is large, resting upon the truncate basal and supporting the ventral sac, which has the form of a tube. The tube is long, sometimes extending beyond the tips of the arms, rather strong; cylindrical except at its junction with the main body, where it becomes much contracted toward one side, the inner passage elliptic, almost linear in its cross section. It is composed of quadrangular plates longitudinally arranged, leaving a deep furrow between the rows lined with fissures which penetrate the test.

The construction of the summit closely resembles that of *Cya-*

thocrinus, except that the arms are recumbent upon the vault. There are five oral plates, upon the sutures between which, and raised above the general level, the arm-joints are imbedded, being covered by small alternating plates like the free arms.

Column round, composed of joints of alternating thickness.

Gissocrinus approaches nearest the Silurian form of *Cyathocrinus*; indeed the form of the calyx and the general aspect are strikingly similar. But they differ in the number of underbasals, which in this genus are reduced to three. Angelin places *Gissocrinus* with *Forbesiocrinus* and both under the *Taxocrinidæ*, which is certainly not a natural group. The long slender proboscis, the single ring of radials within the calyx, show clearly that this genus belongs to the *Cyathocrinidæ*.

Geological position, etc.—Upper Silurian of England and Sweden, so far as known.

The following species have been referred to it:—

1839. *Gissocrinus arthriticus* Phillips. (*Aetinoor. arthriticus*), Murchison. *Silur. Syst.*, p. 674, pl. 17, fig. 8, and Morris, *Cat. Brit. Foss.*, Ed. 2, 1854, p. 70.—Salter, 1859. *March. Siluria*, Ed. 3, p. 635, pl. 14, fig. 7, and *ibid.* Ed. 4; p. 512; Salter, 1873, *Cyathocr. arthriticus*, *Cat. Camb. and Silur. Foss. in Univ. of Cambridge*, p. 124. Angelin. *Gissocr. arthriticus*, *Iconogr. Crin. Suec.*, p. 10, pl. 3, figs. 1-3. Upper Silur. Gotland, Sweden, and Dudley, Eng.
1878. *Gissocr. elegans* Angelin. *Iconogr. Crin. Suec.*, p. 10, pl. 3, fig. 5. Upper Silur. Gotland, Sweden.
1878. (?) *Gissocr. macrodactylus* Angelin. *Iconogr. Crin. Suec.*, p. 10, pl. 18, fig. 1. Upper Silur. Gotland, Sweden.

This species differs from all others referred to this genus by Angelin in the brachials, which are represented in a greater number

9. **ARACHNOCRINUS** Meek & Worthen.

1866. Geol. Rep. Illinois, vol. ii. p. 177.

The above name, with *Cyathocrinus? bulbosus* Hall as type, was proposed by Meek and Worthen for a little group of Crinoids which are distinguished by their spider-like appearance. The calyx in these species, as compared with the long and robust arms, is extremely small, hemispherical, and forms a bulb-like protuberance, from which the arms spread horizontally. These characters distinguish this form readily from *Cyathocrinus*, with which it otherwise agrees, and they are so remarkable that we feel constrained to consider *Arachnocrinus* a distinct genus, and not a subgenus, as suggested by its authors.

We had lately the pleasure of examining the splendid collections of Dr. Knapp in Louisville, where we found two exceedingly interesting specimens, representing different species of this genus, both new. In one, the arms are almost closed, in the other spread out horizontally, thus demonstrating clearly that this Crinoid was capable of folding up its arms, and bringing them to an erect position, which has been doubted by Meek and Worthen, who could not conceive how an animal with so small a visceral cavity could have sufficient muscular power to move such ponderous arms. Dr. Knapp kindly permits us to describe the two species, which will be known as *A. Knappi* and *A. extensus*. Roemer's *Poteriocrinus preformis*, which Meek and Worthen refer to this genus, is but imperfectly known, but we do not doubt that the reference is correct. We also place in this genus *Cyathocrinus granulatus* Angelin, though it differs from the other species in the brachials, which are restricted to one to each ray. We propose the following:—

Generic Diagnosis.—Calyx very small, resembling *Cyathocrinus* in the arrangement of the plates, but more depressed; basal portion rounded. Arms exceedingly robust, generally stretched out horizontally, and arranged around the body, as the arms in *Astrophyton* around the disc.

Underbasals five, small, apparently of equal size. Basals five, the posterior one truncate. Radials wider than high, articulating near occupying almost the entire width of the plate, and more or less concave. The number of brachials differs in the rays, as many as fourteen having been observed; they are cylindrical, wider than

high, and resemble in form and construction the joints of the heavy arms.

Arms long, ramifying several times towards the inner part of the ray, the main arms and branches scarcely diminishing in size; in fact the joints near the tips of the arms are almost as large as the brachials. Both are generally short, quadrangular, except the bifurcating plates, which are comparatively longer. Ambulacral furrow deep. Pinnulæ wanting.

Anal plate one, small, resting upon the truncate basal, and supporting a lateral tube which is in line with the arm bases. The ventral tube was evidently small. In *A. Knappi* it apparently rests directly upon the basal, or probably the anal plate forms a part of the ventral sac. The vault is surmounted by five large oral plates—all other plates in the dome unknown.

Column round, of alternately larger and smaller joints.

Geological Position, etc.—Confined to the Upper Silurian and Devonian so far as known, and found both in Europe and America.

The following species may be referred to this genus:—

1866. *Arachnoerinus bulbosus* Hall. (*Cyathocr. (?) bulbosus*), 15th Rep. N. Y. St. Cab. Nat. Hist., p. 123, pl. 1, figs. 19-22. Upper Helderberg, Devon. Livingston Co., Kentucky.
- *1879. *Arachnoer. extensus* Wachsm. and Spr. (See description below.)
- *1878. (?) *Arachnoer. granulatus* Angelin. (*Cyathocr. granulatus*), Iconogr. Crin. Sæc., p. 23, pl. 16, figs. 1-3. Upper Silur. Gotland, Sweden.
- *1879. *Arachnoer. Knappi* Wachsm. & Spr. (See description below.)

¹ *Arachnoerinus extensus*, n. sp. The body of the only known specimen is not in a condition to exhibit satisfactorily the arrangement and propor-

*1860 *Arachnocr. pilaformis* Roumer (*Posterior pilaformis*), SB. Fauna of West Tenn., p. 54, pl. 4, figs 7 a-d, Meek & Worthen, *Arachnocr. pilaformis*. Geol. Rep. Ill., vol. II, p. 177. Upper Silur. Tenn.

The arms are unknown in this species.

10 VASOCRINUS Lyon.

(Rectified by W. & Spr.)

1857 Geol. Surv. Kentucky vol. 3, p. 485.

Hall—Advance Sheets Pal. New York, Vol. V., Part II, p. 6, containing a list of the Devonian fossils occurring at the falls of the Ohio—placed both species of Lyon's *Vasocrinus* under *Cyathocrinus*, in which he was apparently justified, for Lyon in describing the genus failed to point out any characters by which it might be distinguished from *Cyathocrinus*, except perhaps the peculiar form of the body. In his generic description Lyon mentions the presence of only a single anal plate, but at the same time describes his second species with two anals. On examining the original specimens, both of *V. culens* and *V. sculptus*, in the collection of Dr. Knapp, we arrived at the conclusion that Lyon was correct in separating these species from *Cyathocrinus*, and furthermore, that they are intimately related to certain other species

um. Basals large, larger than the radials, and partly included within the concavity. Radials of unequal size—the posterior ones smaller—semilunate articulating facet strongly excavated, facing outward and almost circular in outline. Brachials very heavy, their number varying in the rays. In the original specimen the left posterior ray has fourteen brachials, the right posterior—evidently recuperated and hence perhaps not showing its normal condition—has eight—the lateral rays twelve to fourteen, and the anterior ray fourteen. The first and only bifurcation visible in the specimen takes place on the second, third, or fourth plate. Arms erect, being otherwise built upon the same plan as in *A. extensus*. Arm joints as heavy as the brachials, cylindrical, much wider than high, with parallel sutures, and without pinnule. All these plates appear as if constricted in the middle, on account of the thickening of the plates toward the sutures. Anal arrangement not clearly disclosed in the specimen, but there appears to be a rather large lateral opening directly above the posterior basal and between two adjoining radials. We can observe no special anal plate, and if it were present it was evidently small, and perhaps formed a part of the ventral tube, which toward the dome is supported by an elongate lozenge-shaped oral plate. Four additional oral plates of a similar form cover the ventral side. Apical dome plates, and the covering of the ambulacral furrow, not preserved. Hamilton Group. Devonian. Near Charleston, Indiana.

which have been referred to various genera and always with difficulty.

In reconstructing the genus, we prefer to make *Vasocrinus Lyoni* (*Cyathocrinus Lyoni* Hall), from Crawfordville, the type, because it is found more perfectly preserved in the arm portion; but we scarcely doubt, to judge from the brachials, as far as they are preserved, that the arms in the Devonian species were constructed in a like manner.

Revised Generic Diagnosis.—Calyx shaped like a low vase; plates thin. Underbasals five, rather small, forming a regular pentagon. Basals large, almost as high as wide, generally depressed toward their angles, four pentagonal or hexagonal, the fifth with an additional side. Radials always wider than high, the upper portion strongly inflected toward the dome. Articulating facet, concave occupying about one-third of the plates, almost circular, deeply notched for the ambulacral groove. Brachials resembling the arm plates, but slightly wider. In *Vasocr. Lyoni*, the only species in which their number is perfectly known, there are two by five (*V. valens* had at least as many), with two arms to the ray.

Arms long, moderately heavy, tapering gradually to the tips. They are simple throughout, so far as observed, but in place of branching they throw off armlets alternately from each side, and these branch once or twice, as in *Botryocrinus* and *Barycrinus*, though they are less robust.

Anal area wide; anal plates generally two, rarely one, arranged as in *Bucyrocetus*. There is one large plate situated between two



Column round, undivided longitudinally (except in *V. dilatatus*); central perforation scarcely of medium size.

This genus occupies a position systematically between *Cyathocrinus* on the one side and *Botryocrinus* and *Barycrinus* on the other. It differs from *Barycrinus* in the delicacy of its body plates, in having two brachials instead of one, in the less robust arms, and in having a round column with a comparatively small and simply constructed passage, in contrast to the pentagonal, divided column, and wide and complicated central canal of that genus. From *Botryocrinus* it differs in the form of the ventral sac and the construction of the arms.

Geological Position, etc.—Devonian and Subcarboniferous; only found in America, save one doubtful species from the Eifel.

The following species are considered as belonging here:—

- 1866. (?) *Vasocrinus dilatatus* Schultze. (*Poterier. dilatatus*, not Hall = *Coeleocr. dilatatus*.) Mon. Echinod. Eifl. Kalk., p. 49, pl. 5, figs. 3, 3 a. Devonian. Eifel, Germany.

This species has the column divided longitudinally, and therein approaches *Barycrinus*, from which it differs in having thin body plates, and a form exactly as in Lyon's typical species *V. valens*.

- 1861. *Vasocr. Lyoni* Hall. (*Cyathocrinus Lyoni*.) Type of the genus. Deso. New. Pal. Crin., p. 5; Bost. Journ. Nat. Hist., p. 298. 1868. Meek & Worthen. *Barycrinus Lyoni*. Proc. Acad. Nat. Sci. Phila., p. 340. Keokuk limest. Subcarb. Crawfordsville, Indiana.

Syn. *Cyathocrinus hexadactylus*, Lyon & Casseday. 1859. Amer. Journ. Sci., p. 74.

Lyon's name has precedence, but being specifically as well as generically incorrect (see note above), we adopt Prof. Hall's later name.

- 1861. *Vasocr. macropleurus* Hall. (*Cyathocr. macropleurus*.) Deso. New. Pal. Crin., p. 5; Bost. Journ. Nat. Hist., p. 295. Meek & Worthen, *Scaphiocr. macropleurus*. Geol. Rep. Ill., vol. v. p. 412. Lower Burl. limest. Subcarb. Burlington, Iowa.

- 1857. *Vasocr. sculptus* Lyon. Geol. Rep. Ky., vol. iii. p. 486, pl. 4, figs. 3 b-e.; Hall, 1877. *Cyathocr. sculptus*. Pal. N. Y., vol. v. (advance sheet No. 2) p. 6. Hamilton Gr., Devonian, above Hydraulic Bed. Jefferson Co., Ky.

- 1857. *Vasocr. valens* Lyon. Geol. Rep. Ky., vol. iii. p. 485, pl. 4, figs. 3, 3 a. Hall, 1877. *Cyathocr. valens*. Pal. N. Y., vol. v. (advance sheet No. 2) p. 6. Hamilton Gr. Devonian, above the Hydraulic Bed. Near Greenville, Ky.

11. OPHIOCRINUS Angolia.

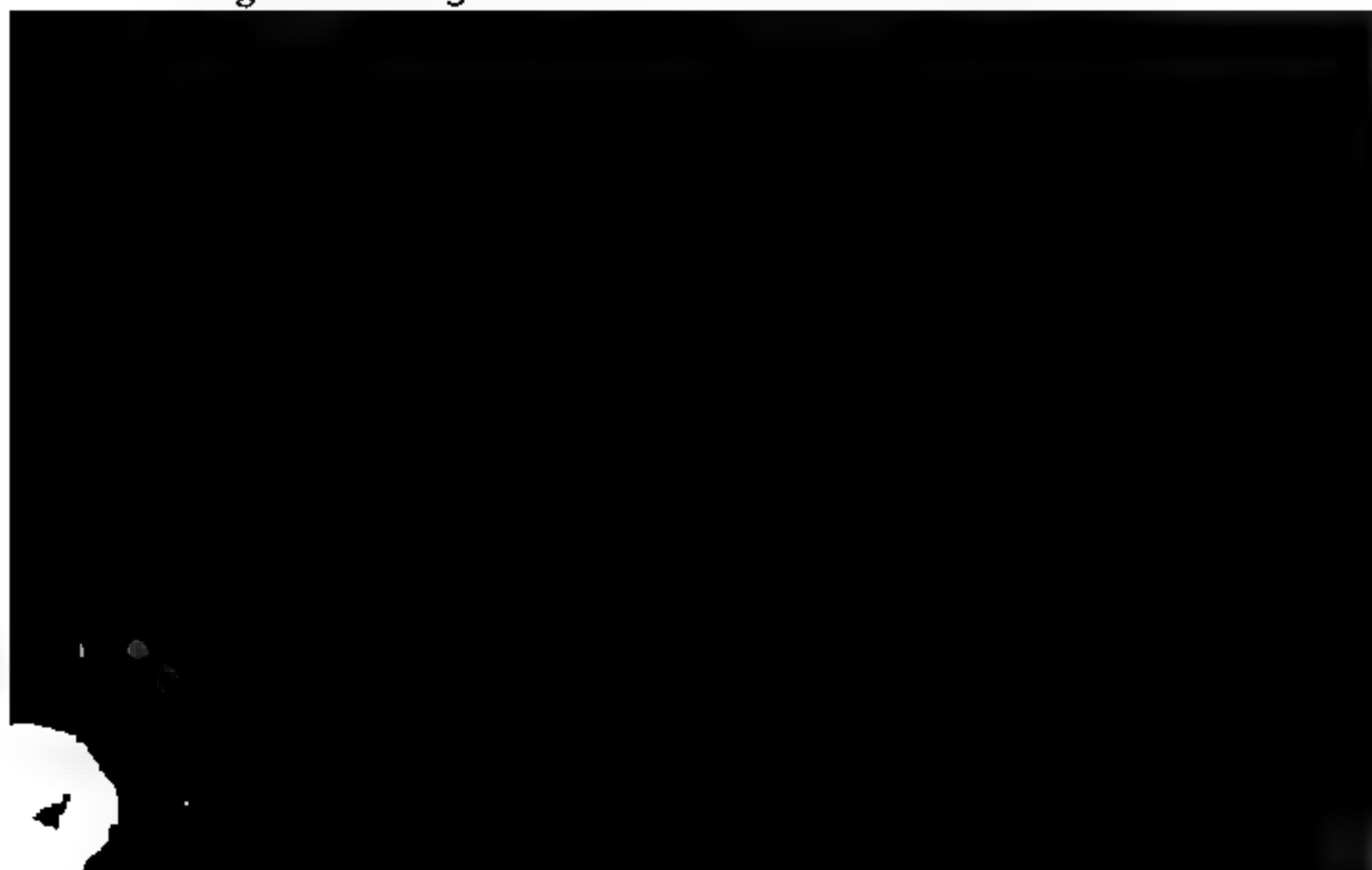
1878. Iconogr. Crin. Suec., p. 24.

In the form and structure of the calyx this type resembles *Cyathocrinus*, but in the position of the arms it is like *Arachnocrinus*, from which it is perhaps only subgenerically distinct.

Underbasals five, four of medium size, equal, thin, upper edges meeting at right angles, except the fifth is truncated above. Radials five, lunulate; articulating surface deeply concave, and occupying almost the entire width of the plate. Brachials spreading out horizontally, varying in number from one to four in the different rays; very short but heavy. Only one anal plate.

Arms directed downward; composed of joints similar to the brachials, being, however, slightly narrower and longer. Total length of arms unknown. *O. crotalurus* had apparently only ten arms; in the original specimen some eight or nine arm joints are preserved without any signs of bifurcation. The arm grooves are rather narrow, covered by two rows of plates; with short lateral grooves given off from each side of the main furrow, within the arm joints, similarly covered, and which are evidently recumbent pinnulæ.

The condition of the ventral sac is the most remarkable feature of the genus. Instead of going straight upward, it bends close to the base, and coils upon itself spirally twice, decreasing in thickness toward the upper end. It is composed of regular rows of hexagonal plates alternately arranged, with a rather deep longitudinal ridge bordered with fissures on each side.



A. Typical form

The crinoids of this type resemble in general form a tree with many branches and branchlets. Calyx small, cyathiform, unsymmetrical.

Underbasals five, slightly protuberant. Basals five, three of them equal, the other two of somewhat different form, due to their abutting against the anal plates. Radials large, articulating surface concave, occupying more than three-fourths of the width of the plate. Brachials less than one-half the size of the radials, wider than high, their number varying in the rays from two to five.

Each ray is composed of two main arms from which, throughout their entire length, spring two rows of branches, given off on alternate sides from every second or third joint, and which extend to the very top of the specimen. The secondary arms branch again, throwing off branchlets right and left, which themselves ramify, thus producing branches of a third and fourth order. The main arms are heavy, almost as wide at the base as the brachials, and decreasing in size very gradually toward the tips. The secondary branches are about two-thirds the size of the former, and those of the succeeding orders are slender, short, not reaching to the top of the specimen. The plates of arms and branches of corresponding position, throughout the specimen, are of equal width and height, those of the branches being relatively shorter. Articulating face of arm joints and brachials circular.

Anal plates two, arranged as in *Homoerinus*; the lower one rhomboidal, situated between two basals, the right posterior radial and the second anal. The latter is larger, similar in form to the radials, almost as large, and in line with them. Ventral sac of medium width, composed of very regular hexagonal plates, alternately arranged in rows. It is in form of a tube, and ascends almost vertically to about one-fourth the length of the arm, where it bends abruptly towards the posterior side and coils upon itself like a snail. Anal aperture apparently located anteriorly at the very base of the tube.

Vault composed of a large number of small plates the exact arrangement of which has not been ascertained.

Column round, composed of thin joints.

Holycrinus agrees closest with *Barycrinus*, to the description of which we refer for comparison.

Geological position, etc.—Known only in the Upper Silurian of Sweden, where it is represented by the two following species:—

1878. *Botryocrinus ramosissimus* Angelin. Iconogr. Crin. Suec., p. 24, pl. 20, fig. 8 and Pl. 23, fig. 14. Upper Silur. Gotland, Sweden.

1878. *Botryocr. corallum* Angelin. Iconogr. Crin. Suec., p. 24, pl. 15, fig. 9, and pl. 23, figs. 15, 16, and pl. 24, fig. 4. Upper Silur. Gotland, Sweden. —

B. Subgenus **SICYOCRINUS** Angelin.

1878. Iconogr. Crin. Suec., p. 23.

Sicyocrinus cucurbitaceus Angelin, the only known species of this type, is so closely related to *Botryocrinus* that we think it should be placed thereunder as a subgenus. The calyx, in form and arrangement of plates, is alike in both, and even the arms and ventral sac are constructed upon the same plan, but which is differently executed.

In *Sicyocrinus* there are five single arms, in place of five pairs, which give off branches from one side only, and not alternately from both sides as in the typical form. The branches, which are represented up to the fourth order, diverge from the arm at a less angle, and those of the third and fourth orders are comparatively longer. The brachials, as well as the arm joints throughout the branches, are from two to three and even four times longer than wide, and have a deep ambulacral furrow. The ventral sac, as in *Botryocrinus*, first ascends, then turns abruptly toward the posterior side, and bends until its extremity points downwards. It is now very remarkable that the portion of the tube which is bent over is not only firmly attached exteriorly to the lower part by a

tures. In the first place the species are more robust, having thicker and more ponderous plates which form a more shallow cup. They also differ in having generally an extra quadrangular anal piece, which is inserted toward the right lower margin of the other anal, and although it is often very small, and in some rare cases entirely wanting, it is characteristic as a rule, while such a plate never occurs in *Cyathocrinus*. A more constant difference is observable in the brachials, which are proportionally shorter and wider, particularly the first one, which often presents an almost linear appearance. In *Cyathocrinus* the number of brachials is very irregular, but in *Barycrinus*, without exception, it is fixed at two. The best means of distinction, however, is afforded by the arms, which in *Barycrinus* are composed of rather short, heavy, rounded pieces, with very narrow ambulacral grooves, while *Cyathocrinus* has rather slender arms and wide, deep furrows. The arms also instead of regularly dichotomizing, so as to form equal divisions, are simple in *Barycrinus* and give off armlets at regular intervals. The column in this genus is almost unique in its construction, and very distinct from that of *Cyathocrinus*. It is not only stouter and subpentagonal, but is divided longitudinally into five sections, and has a large, highly organized central canal.

Barycrinus has its closest affinities with *Rotryocrinus* Angl., with which it agrees in the general construction of the arms and in the anal arrangement, but from which it is easily distinguished by its massive body plates, the number and proportion of its brachials, and by the column.

Genere Dinopora.—General form of the calyx basin or low cup-shaped, often attaining a gigantic size; plates massive, more or less gibbous or protuberant. Surface coarsely corrugated, granulated, or striated, with frequently a depression at each angle between the plates.

Underbasals five, of less than medium size, fully one-half extending beyond the column, their points in form of little triangles bent upward.

Basals large, three of them—sometimes four—hexagonal, the other two heptagonal. Radials five, very unequal in size, the right posterior and often the anterior one much the lowest, all of them wider than high, pentagonal in outline; articulating scar facing outward, concave, occupying from one-half to fully two-thirds the width of the plate. Brachials, two to each ray, wide

and short, articulating face circular; the first one extremely short in the middle, one fourth as high as wide, and becoming still thinner or wedge-shaped at each side; the second is a little longer in proportion and presents a subtrigonal outline, supporting on its sloping upper sides two arms.

Arms moderately long, robust, scarcely decreasing in size, and generally simple throughout, though sometimes they branch once on the third or fourth plate in some of the rays—but never in the anterior one—and only in one arm to a ray, the other arm always remaining simple. In one species, probably *B. tumida* Hall, from the Keokuk limestone, the antero-lateral rays are entirely simple, the arm plates and brachials forming a continuous series. All the main arms, instead of bifurcating, give off at regular intervals, alternately on opposite sides, and from the inner margins of the plates, short, rounded, simple armlets, which in most species throw off secondary branches as in *Botryocrinus*, and these armlets, here as there, probably performed the office of pinnule. The arm joints are simple, round, mostly shorter than wide, with a narrow, almost linear ambulacral furrow.

Anal plates generally two, never more. The lower plate which is often very small is wanting in some few species, and in very young specimens is frequently undeveloped, but when present, it is located against the posterior basal and beneath the right radial; the larger, which stands in line with the radial, is generally of about their height and half their width, quadrangular in outline. Ventral sac and vault unknown, but both were evidently of a delicate structure, as we have never seen a trace of them in any of our specimens.

Column short, obtusely pentagonal, divided longitudinally into five sections, which are in a radial position. The sutures are interradial, the opposite of *Heterocrinus* in which they are radial; they are bordered by little pores which apparently communicated with the large pentangular central canal at its five angles. These sutures extend throughout the entire length of the stem and partly to the radicular cyrri, which are strong, ramifying, and radially situated. The genus had evidently no cyrri along the column, for we have examined with reference to this point a number of specimens showing several feet of stem from near the body to, and including the root, without discovering any trace of them. The radicular cirrhi, which are long and strong, are given off radially.

The inner canal is large throughout and increases in size toward the root.

Geological position, etc.—The genus has a very limited range. It occurs so far as known only in the Subcarboniferous, and in America, where it first appears in the Lower Burlington limestone. It is found in the greatest profusion and size in the Keokuk, and has only two representatives in the Warsaw, where it becomes extinct.

We recognize 23 species, 2 of them being doubtful.

- 1860 *Baryertinus angulatus* Meek & Worthen (*Cyathocr. angulatus*.) *Proc. Acad. Nat. Sci. Phil.* p. 391, *Geol. Rep. Ill.*, vol. ii p. 334, pl. 17, fig. 4. *Baryer angulatus*, 1868, *Proc. Acad. Nat. Sci. Phil.*, p. 340. Burlington and Keokuk transition bed. Subcarb. Nauvoo, Illinois (probably syn. of *B. sculptatus* Hall).
- 1838 *Baryer. bullatus* Hall. (*Cyathocr. bullatus*.) *Geol. Rep. Iowa*, vol. i pl. ii p. 624, pl. ix fig. 1. *Baryer bullatus* M. & W. 1868. *Proc. Acad. Nat. Sci. Phil.*, p. 340. Keokuk limestone. Subcarb. Keokuk, Iowa.
Syn. Cyathocr. protuberans Hall. *Geol. Rep. Iowa*, vol. i pt. ii. p. 626, pl. ix fig. 2.
- 1836 *Baryer. cornutus* Owen & Shumard (*Cyathocr. cornutus*.) *Jour. Acad. Nat. Sci. Phil.* (2d ser.), vol. ii, U. S. Geol. Surv. Wiro., Iowa, and Minn., p. 291, pl. 5, fig. 8 a, b, *Baryer cornutus*, 1868. *Proc. Acad. Nat. Sci. Phil.*, p. 340. Lower Burlington limestone. Subcarb. Burlington, Iowa.
- 1860 *Baryer. crassibrachiatus* Hall (*Cyathocr. crassibrachiatus*.) *Supp. Geol. Rep. Iowa*, p. 60, *Baryer crassibrachiatus*, 1868. *Proc. Acad. Nat. Sci. Phil.*, p. 340. Keokuk limestone. Subcarb. Warsaw, Ill.
1873. (?) *Baryer. geometricus* Meek & Worthen (*Cyathocr. ? undetermined*.) *Geol. Rep. Ill.*, vol. iii pl. 20, fig. 5 a-c, vol. v pl. 12, fig. 3. Keokuk limestone. Subcarb. Warsaw, Ill.

The original specimen is very imperfect, possibly *Niptero-crinus*.

- *1867 *Baryer. hirculeus* Meek & Worthen (*B. Hoveyi* var. *hirculeus*.) *Proc. Acad. Nat. Sci. Phil.*, p. 341. *Geol. Rep. Ill.*, vol. v p. 455, pl. 13, fig. 2. Keokuk limestone. Subcarb. Crawfordville, Ind.

This is a good species, and not a variety.

- 1861 *Baryer. Hoveyi* Hall (*Cyathocr. Hoveyi*.) *Broc. New Pal. Crin.*, p. 5, *Bull. Jour. Nat. Hist.*, p. 293. Meek & Worthen, 1873. *B. Hoveyi*, *Geol. Rep. Ill.* vol. v p. 456, pl. 13 fig. 1. Keokuk limestone. Subcarb. Crawfordville, Ind.
- *1862 *Baryer Kelloggi* White (*Cyathocr. Kelloggi*.) *Proc. Bos. Soc. Nat. Hist.*, p. 7. Keokuk limestone. Subcarb. Diggsville, Ill.
- 1836 *Baryer. magister* Hall (*Cyathocr. magister*.) *Geol. Rep. Iowa*, vol. i. pl. i. pl. ix figs. 2, 3. *B. magister*, 1868, *Proc. Acad. Nat. Sci. Phil.*, p. 340. Keokuk limestone. Subcarb. Keokuk, Iowa.

1868. *Baryer. magnificus* Meek & Worthen. Proc. Acad. Nat. Sci. Phil., p. 340. Geol. Rep. Ill., vol. v. p. 483, pl. 12, fig. 2. Keokuk limestone. Subcarb. Biggsville, Ill.
1873. *Baryer. mammatus* Worthen. Geol. Rep. Ill., vol. v. p. 486, pl. 15, fig. 4. Keokuk limestone. Subcarb. Otter Creek, Ill.
1873. *Baryer. pentagonus* Worthen. Geol. Rep. Ill., vol. v. p. 487, pl. 15, fig. 3. Keokuk limestone. Subcarb. Jersey Co., Ill.
- *1850. *Baryer. rhombiferus* Owen & Shumard. (*Poterioer. rhombiferus*.) Jour. Acad. Nat. Sci. Phil., new ser., vol. ii. U. S. Geol. Surv. of Wisc., Iowa, and Min., p. 595, pl. 5 B, figs. 2 a, b, c. Lower Burl. limestone. Subcarb. Burlington, Iowa.
1866. *Baryer. sculptilis* Hall. (*Cyathoer. sculptilis*.) Supp. Geol. Rep. Iowa, p. 59; *B. sculptilis*, 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Upper Burl. limestone. Subcarb. Burlington, Iowa.
- Syn. Cyathoer. latus* Hall, 1861. Desc. New Pal. Foss., p. 5; and Bost. Jour., p. 292.
- Syn. Cyathoer. scitulus* Meek & Worthen, 1863. Proc. Acad. Nat. Sci. Phil., p. 393.
- 1861. *Baryer. solidus* Hall. (*Cyathoer. solidus*.) Desc. New Pal. Crin., p. 5. Bost. Jour. Nat. Hist., p. 293; *B. solidus*, 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Upper Burl. limestone. Subcarb. Burlington, Iowa.
1869. *Baryer. spectabilis* Meek & Worthen. Proc. Acad. Nat. Sci. Phil.; Geol. Rep. Ill., vol. v. p. 530, pl. 20, fig. 8. Warsaw limestone. Subcarb. Jersey Co., Ill.
1868. *Baryer. spurius* Hall. (*Cyathoer. spurius*.) Geol. Rep. Iowa, vol. i. pt. ii. p. 625, pl. 18, figs. 7, 8; *B. spurius*, 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Keokuk limestone. Subcarb. Keokuk, Iowa.
- *1858. *Baryer. stellatus* Hall. (*Cyathoer. stellatus*.) Geol. Rep. Iowa, vol. i. pt. ii. p. 623, pl. 16, figs. 3, 8. Keokuk limestone. Subcarb. Keokuk, Iowa.
- Syn. Cyathoer. quinquelobus* Meek & Worthen, 1865. Proc. Acad. Nat. Sci. Phil., p. 150. Geol. Rep. Ill., vol. iii. p. 519, pl. 20, figs. 6 a, b.
1875. (?) *Baryer. striatus* Worthen. Geol. Rep. Ill., vol. vi. p. 515, pl. 29, fig. 5.

1858. *Baryer. tumidus* Hall. (*Cyathocr. tumidus*.) Geol. Rep. Iowa, vol. i. pt. ii. p. 624, pl. 18, figs. 1 b, c. *B. tumidus*, 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Keokuk limest. Subcarb. Keokuk, Iowa.
1861. *Baryer. Wachsmuthi* Meek & Worthen. (*Cyathocr. Wachsmuthi*.) Proc. Acad. Nat. Sci. Phil., p. 136. Geol. Rep. Ill., vol. iii. p. 482, pl. 16, fig. 5; *B. Wachsmuthi*, 1868. Proc. Acad. Phil., p. 340. Lower Burl. limest. Subcarb. Burlington, Iowa.

14. *POTERIOCRINUS*, Miller.

1821. *Poteriocrinites* Miller. A History of the Crinoidea, p. 65.
1835. *Poteriocrinus* Agassiz. Mem. de la Soc. de Neuch., vol. i.
1838. *Poteriocrinus* Phillips. Geology of Yorkshire, p. 205.
1843. *Poteriocrinus* Austin. Rec. and Foss. Crin., p. 68.
1853. *Poteriocrinus* de Koninck & Lehon. Recher. s. l. Crin. Belg., p. 84.
1849. *Cupressocrinus* McCoy. Ann. & Mag. Nat. Hist., ser. ii. vol. ii. (not Goldf.).
1858. *Scaphiocrinus* Hall. (Subgenus of *Poteriocr.*) Geol. Rep. Iowa, p. 550. (Not *Graphiocrinus* de Koninck & Lehon.)
1860. *Poteriocrinites* Meek & Worthen. Geol. Rep. Ill., vol. ii. p. 179.
1866. *Scaphiocrinus* Meek & Worthen. (Subgenus of *Poteriocr.*) Ibid. vol. ii. p. 237.
1866. *Poteriocrinus* Schultze. Mon. Echinod. Eifl. Kalk. p. 42.
1867. *Hydriocrinus* Trautschold. Bull. de la Soc. Imp. des Naturalists de Moscou, p. 16.

(Diagram Pl. 2. No. 7.)

In no other genus of the Crinoids is there found so much confusion as in the one now under consideration. This is partly due to the imperfect preservation of the specimens from which the earlier descriptions were made, and also, no doubt, to the species themselves upon which Miller founded the genus. Neither of his two species of *Poteriocrinus* can be considered characteristic types of the genus, and unfortunately among his four species of *Cyathocrinus*—the genus with which *Poteriocrinus* was afterwards so often confounded—only one can be properly claimed for that genus, two of them having been later referred to very distinct groups, and the fourth is a *Poteriocrinus*.

According to Miller, the pelvis of *Poteriocrinus* is composed of five pentagonal plate-like joints, supporting five hexagonal intercostal plate-like joints, and five plate-like scapulae with an intercostal and an interscapular plate interposed; an arm proceeds from each scapula; column round, composed of narrow joints with a central perforation. This embraces everything in Miller's description which might be deemed of generic importance,

but it is fully sufficient for identification, as it affords the means of separating this form from the only other genus of this family then known. It gives us unquestionable evidence of the existence of at least two anal plates within the calyx, which are plainly shown in the diagrams; while in Miller's typical species of *Poteroocrinus* only a single anal plate is mentioned or figured, which is wedged in between the scapulæ or first radial plates.

In the description of *P. crassus*, which is Miller's first species, and ought to be the type of the genus, he gives additional information regarding the scapulæ or radials. They are described as thin plates, obliquely truncated at the upper margins, excavated with a horseshoe-like impression occupying scarcely more than one-third the width of the plates. Miller's second species agrees well with the preceding. It has only one brachial, which is a bifurcating plate, narrow, four to five times longer than wide, supporting an arm on each side. Only one arm is preserved which has the same dimensions as the brachial, and a deep ambulacral furrow. Miller also found minute plates indicating that the abdominal cavity and perhaps also the excavated sulci in the arms were protected by a plated integument.

It thus appears that the calyx of *Poteroocrinus*, according to Miller, is composed of three rings of plates, 5 underbasals, 5 basals, and 5 radials; that there are not less than two anal plates, one alternating with the basals (intercostals) and another between the radials; that the radials in the two then known species are excavated for the attachment of the brachials, the articulating scar occupying only one-third the width of the plate; that in *P. tenuis*, the only species in which any part above the calyx was known, there is only a single brachial which is a very long, slender plate, and that the arm joints, so far as known, were found to be long and proportioned like the brachials. The calyx of both species is subconical, and both came from the Subcarboniferous of England. Miller describes the basals as being hexagonal, which is not quite correct. It was shown by de Koninck and Lebon that three of the subradials (basals) are hexagonal or heptagonal and of a similar form, while the other two—those in contact with the anal plates—have one or two additional sides, and are slightly larger. The same authors also point out the fact, that four of the radials are of equal size, pentagonal, regularly alternating with the basals, but that the right posterior one, which is rather smaller and

elevated above the line of the others, is less regular in form and rests upon the truncated upper side of the basal and against the two anal pieces, differing therein from *Cyathocrinus*, in which basals and radials alternate all around. They consider the latter a very important distinction between the two genera, but they further assert that the best character for separation is to be found in the presence of a single aperture in the dome of *Poteriocrinus*, and of a separate oral and anal opening in *Cyathocrinus*. This unfortunate and altogether incorrect statement on the part of de Koninck has caused the utmost confusion, and when it was shown by Meek & Worthen that the supposed oral aperture is closed in perfect specimens in the one as well as in the other, some of the leading authorities in Europe, who had previously expressed their doubts as to the genus *Cyathocrinus*, wished to abandon it altogether. We, for our part, cannot endorse this proposition, for we think that the two genera are nicely defined by good generic characters; and that has been the opinion of the American Paleontologists generally, which has probably arisen from the fact that this country has produced far better specimens.

But while American authors agree thus far, they differ in regard to the proper limits of the genera. When in the course of recent years a great variety of forms of *Poteriocrinus* were discovered, Hall undertook to divide them subgenerically, but in this he was not very successful. In establishing his subgenus *Scaphiocrinus*, he selected *Scaphocr. (?) simplex* as type, a species which in its anal arrangement and arm structure, though clearly distinct from *Poteriocrinus*, agrees exactly with *Graphocrinus* de Koninck & Lehou. The majority of species, however, which were described under *Scaphiocrinus*, agree substantially, both in the arms and anal area, with *Poteriocrinus*, and we see no possibility of separating them. This may appear strange, for, on looking over a large collection of *Poteriocrinus*, it seems to embrace a number of very different groups, but an attempt to separate them will invariably result in finding but few species agreeing in the same points.

Hall defines *Scaphiocrinus* as follows: radials 2×5 , both pentagonal, the first with the upper side straight or obliquely concave, the second with the lower side straight, often much elongated, and the plates contracted or concave on each side, anals four or more, arms double from their origin, or rarely simple in the anterior ray; arm plates simple, often wedge-shaped, with pinnules

originating on the longer side of the plate; the line of articulation between first and second radials more or less gaping exteriorly, and the edge of the plate rounded. Among the species referred to *Scaphiocrinus* there are some with two brachials (three radials, Hall), others with but one; some with long slender brachials, others with short ones; some in which the brachials occupy the entire width of the upper margin of the radials, others scarcely one-third, and with a horseshoe-like articulating scar; some with a shallow almost concave calyx, others with a nearly cylindrical one; in some species the arms are simple, with short joints, in others branching, with long joints, or *vice versa*; in some the pinnulae are strong, and the arms zigzag, in others thin and short, and the arms straight; but all agree, with the exception of the few species which we refer to *Graphocrinus* (and among the latter Hall's *Scaphiocr. simplex*), in the construction of the anal area, which is exactly as described in *Poteriocrinus*, and in having a strong cylindrical or slightly club-shaped ventral sac.

Our own attempt to subdivide *Poteriocrinus* subgenerically met with but little better success, though we had the advantage of subsequent discoveries. A division based upon the number of free radials—or brachials as they are now called—cannot be carried out practically. Species with two brachials are not otherwise distinct from those with but one, and Hall himself, who founded *Scaphiocrinus* upon the presence of a single brachial, and likewise, Meek and Worthen, included therein several species with an additional brachial. In this they were evidently justified, for the additional plate, according to our views, is only a supplementary piece, which facilitates the motion of the arms, but has no effect upon the general structure of the animal. The two brachials combined have the form and size of the single one—in fact it is a compound plate, and this term properly expresses its relations.

Nor can the gaping sutures be regarded as of generic importance. We look upon this structure merely as another mode of articulation—taking place upon a straight hinge line instead of a sloping semicircular scar—and the gradations from one form to another are so close, that it is impossible to separate groups thereby. Nevertheless, to facilitate the identification of species, which is always difficult when there is a large number in a single group, we have separated *Poteriocrinus*, as well as could be ascertained from the descriptions and figures, with the aid of our own exten-

sive collections, into six divisions, for which we propose distinct names. In doing so, however, we wish to have it understood that we scarcely deem the characters upon which they are based sufficiently important even for subgeneric separation. Still better distinctions may be discovered hereafter, and in the mean time this arrangement will prove very convenient for comparative study.

The genus *Poteriocrinus*, of which there are now over a hundred species known and described, was thought by Miller to be represented altogether by two, and of these the material at his command was very limited and imperfect, so that probably in order to make the most of what he had—to render his descriptions as perfect as possible and to prove some of his theories more effectually—he in some cases reconstructed the specimens from fragmentary pieces, which he supposed to be parts of the same species, but which, as we now know, belonged, at least in some instances, to different genera. The fact that Miller's figures cannot be relied upon, and that his best original specimens can nowhere be found (Austin), has produced continual trouble. Some of his species have been badly defined by subsequent writers. This is evidently the case with his typical species *P. crassus*. It is true Miller's figures are not so intelligible as might be wished, yet they prove plainly that the plates of the calyx in that species are thin, with elevations radiating from a point near the centre of the plates and meeting at the sutures those from adjoining plates. Such costae—as these elevations have often been called—are found very prominent in several species of *Poteriocrinus* from the Burlington limestone, and in these they are not mere external markings, but are produced by a flexure of the plate itself. That the structure was similar in *P. crassus* is plainly indicated by Fig. 7 G, which represents folds on the inner surface of a radial—not intercostal as Miller makes it. In the figures of de Koninck's so-called *P. crassus*, the plates, on the contrary, are massive, without plications, the surface simply granular, and the articulating scar, which in Miller's specimens scarcely fills one-third the width of the radials, extends almost the entire breadth of the plate. Strange as it may appear, it seems as if de Koninck took the plications—which in Miller's principal figures somewhat indistinctly resemble the parasitic excrescences of one of his own specimens—to be the work of parasites, and in no other way can we account for supposing such distinct forms to belong to the same species.

same difficulty exists in regard to Austin's figures, who has represented under *P. crassus* two or more distinct species.

The identification of *P. tenuis*, Miller's second species, is equally doubtful, and in our opinion altogether unreliable. The arms as there figured certainly do not belong to that calyx nor that column, and we are confident that the two latter pertain to *Poteriocrinus* and the former to *Cyathocrinus*. We may here remark that while we have experienced scarcely any difficulty in referring the known species to *Poteriocrinus* and *Cyathocrinus* respectively, we find in all of Miller's species, in one way or another, characters altogether at variance with the rules we have laid down for distinguishing the two genera. Under these circumstances the question arises whether it is not in the interest of science to adopt a new or at least an additional type for the genus. This may somewhat conflict with the rules and practices of naturalists, but in this case we consider it the only adequate remedy. We accordingly propose for this purpose *Poteriocrinus notabilis* Meek & Worthen, from the Burlington limestone, the original of which, formerly in the collection of C. W. and now in the Museum of Comp. Zool. of Cambridge, Mass., is figured in the Geol. Rep. Ill., vol. v., pl. 1, fig. 9. We have selected this species because it is found in very perfect preservation, and because it agrees most closely with Miller's typical species, and certainly belongs to the same division.

Making this the typical form, we further propose as sections under it *Scaphocrinus* Hall, with *S. dichotomus* Hall's second species (the first being referred to *Graphocrinus*) for type; *Parisocrinus* W. & Spr., with *Poteriocr. perplexus* M. & W.; *Pachylocrinus* W. & Spr., with *Poteriocr. subæqualis* W. & Spr. (Hall's *Poteriocr. æqualis*); *Scytalocrinus* W. & Spr., with *Poteriocr. robustus* Hall, *Devadocrinus*, with *Scaphocr. scalaris* M. & W., respectively as typos, and as we regard these sections rather as variations of the genus, which hardly rise to the dignity of subgenera, we shall for the present write the names with that of the parent genus prefixed. There are some other species, only known from the calyx which could not be satisfactorily arranged under the above groups, and these will be found in a list by themselves.

Generic Diagnosis.—General form of body with arms, elongate, subcylindrical, expanding uniformly upward. Calyx very variable

in shape, subconical or subturbinate, sometimes bell, cup, or almost saucer shaped; arrangement of plates unsymmetrical.

Underbasals five, equal in form and size, forming a more or less depressed pentagonal cup. Basals five, three of them hexagonal or heptagonal, and of the same size, the two others—those adjacent to the anals—slightly larger, and with one or two additional sides. Radials wider than high, four of a similar pentagonal form, and alternating regularly with the basals; the fifth slightly smaller, elevated above the level of the others, less regular in form, resting upon the truncated upper side of one basal and against two anal pieces. Articulating surface very variable, the scar for the attachment of the brachials occupying in the typical species scarcely one third of the upper edge, but in some species it extends across the entire margin of the radials with a hinge-like apparatus for articulation. Brachials one to two or more, their number the same in four of the rays, the anterior having often a few additional plates. In species with only one brachial it is generally long and laterally constricted; in those with two brachials, the first is quadrangular and short, and both combined are equivalent in form and size to the single plate of the other type.

Arms simple or branching; the anterior ray, frequently less developed than the others, is sometimes simple throughout; composed of single joints, generally at least as high as wide, often much higher, more or less wedge shaped, and throwing off pinnules alternately. In species whose pinnules have a decidedly zigzag arrangement they are remarkably strong.

Anals three (rarely four) within the calyx, in two rows alternately arranged, the lower one pentagonal, resting against the sloping upper side of the posterior basal and the radial to the right, the second supported by the upper truncated side of the posterior basal, having on the left a radial, on the right the first and third anal plates, the third being sometimes partly above the level of the calyx. Succeeding plates hexagonal, decreasing in size upwards, forming a part of the ventral sac. Ventral sac upright, strong, cylindrical, sometimes club shaped, either extending up to the top of the arms or more than half way, frequently crowned with a set of long spines. Plates of the sac hexagonal, and pierced at the sutures with pores or fissures, which penetrate the lateral margins of the plates. Anal opening rarely observed,

but in all cases, so far as known, low down and situated laterally, not posteriorly.

Dome constructed like that of *Cyathocrinus*. Apical dome plates frequently pushed toward the front by the large ventral sac.

Column round or pentagonal, composed of thin joints with a small central aperture.

Geological position, etc.—*Poteriocrinus* has not been found in the Silurian, neither in this country nor in Europe; the few species which were recorded from that age having since been referred to *Dendrocrinus*, *Homocrinus*, etc. It flourished to some extent in the Devonian, but reached its climax both in variety of form and number of individuals in the Subcarboniferous. There are known 17 species from the Devonian and 99 from the Subcarboniferous, of which 27 are from Europe and 89 from America. The species are arranged under the respective sections as follows:—

A. Typical form.

Calyx obconical, plates delicate, with elevated wrinkles or radiating plications. Radials with a semicircular scar facing outward, and deeply notched, not filling the full width of the plate. Brachials one by five, long, laterally constricted in the middle. Sutures somewhat gaping. Arms long and branching. Ventral sac very long and heavy. Column round.

1866. *Poteriocrinus angulosus* Schultze. *Echinosd. Eifl. Kalk.*, p. 56, pl. 5, figs. 3, 3 a. Devonian. Eifel, Germany.

1821. *Poteriocr. crassus* Miller. (Miller's type of the genus.) *Nat. Hist. Crin.*, p. 68, with figures, Schlottstein, 1822. *Nachtr. Petrefactenkunde*, vol. i.

- 1839. *Poteriocer. notabilis* Meek and Worthen. (*Scaphiocer. notabilis*.) Proposed type of the genus. Proc. Acad. Nat. Sci. Phila., p. 148. Geol. Rep. Ill., vol. v. p. 410, pl. 1, fig. 9. Lower Burl. limest. Subcarb. Burlington, Iowa.
1862. *Poteriocer. obunus* White. Proc. Bost. Soc. Nat. Hist., p. 11. Lower Burl. limest. Subcarb. Burlington, Iowa.
1842. *Poteriocer. plicatus* Austin. Ann. and Mag. Nat. Hist. (ser. 1), vol. x. p. 108; *Id.*, vol. xi. p. 196. Mon. Rec. and Foss. Crin., p. 79, pl. 9, figs. 4 a-f; DeKoninck and Lehon, Recherch. Crin. Belg., p. 100, pl. 1, fig. 11. Subcarb. Bristol, England, and Tournay, Belgium.
1864. *Poteriocer. spissus* DeKon. and Lehon. Recherch. s. les Crin. Belg., p. 100, pl. i figs. 9 a, b. Subcarb. Avon, England.
1866. *Poteriocer. stellaris* Schultze. Mon. Echinod. Eif. Kalk., p. 49, pl. 5, fig. 2. Devonian. Eifel, Germany.
- 1861. *Poteriocer. Whitei* Hall. (*Scaphiocer. Whitei*.) Desc. New. Pal. Crin., p. 7, Bost. Journ. Nat. Hist., p. 306. Lower Burl. limest. Subcarb. Burlington, Iowa.

B. SCAPHIOCRINUS Hall (modified by W. & Spr.).

1858. *Scaphiocrinus* Hall (subgenus of *Poteriocer.*). Geol. Rep. Iowa, vol. i. pl. ii. p. 550.
1867. *Hydriocrinus* Trautschold, Bull. de. Moscou, p. 16.

Calyx obconical to semiovoid. Radials truncate above; brachials simple or compound, and similar in form to the radials, but truncate below; line of articulation straight, occupying the full width of the plate; sutures gaping. Column round, obscurely pentagonal, or even pentalobate.

a. Species with a Simple Brachial.

- 1859. Pot. (*Scaphiocrinus*) *equalis* Hall (not *Scaphiocer. equalis* Hall, 1861, Bost. Journ. Nat. Hist., p. 316 = Pot. (*Pachylocrinus*) *irregularis*, W. & Spr.). Supp. Geol. Rep. Iowa, p. 63. Lower Burl. limest. Subcarb. Burlington, Iowa.
- Syn. *Scaphiocer. solidus* M. & W. 1861. Proc. Acad. Nat. Sci. Phila., p. 60.
- Syn. *Scaphiocer. tenuidactylus* M. & W. 1865. Proc. Acad. Nat. Sci. Phila., p. 156. Geol. Rep. Ill., vol. iii. pl. 18, fig. 10.
- 1864. Pot. (*Scaphiocer.*) *corycea* Hall. (Pot. *corycea*) 17th Rep. N. Y. St. Cab., p. 57. Geol. Surv. Ohio, Pal., vol. ii. p. 173, pl. 12, fig. 9. Waverly Gr. Subcarb. Richfield, Ohio.
1869. Pot. (*Scaphiocer.*) *coreyi* Meek & Worthen (not Pot. *coreyi*, Worthen. Geol. Rep. Ill., vol. vi. p. 514 = Pot. *Seytalocrinus grandis*, W. & Sp.). Proc. Acad. Nat. Sci. Phila., p. 148. Geol. Rep. Ill., vol. v. pl. 15, fig. 1. Keokuk limest. Subcarb. Crawfordsville, Ind.
1864. Pot. (*Scaphiocer.*) *crineus* Hall. 17th Rep. N. Y. St. Cab., p. 56. Geol. Surv. Ohio, Pal., vol. ii. p. 172 pl. 12, figs. 6, 7. Waverly Gr. Subcarb. Richfield, Ohio.
1868. Pot. (*Scaphiocer.*) *dactyliformis* Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 670, pl. 17, fig. 6. St. Louis limest. Subcarb. St. Louis, Mo.

1869. Pot. (Scaphioer.) *delicatus* Meek & Worthen. Proc. Acad. Nat. Sci. Phila., p. 144; Geol. Rep. Ill., vol. v. p. 407, pl. 1, fig. 10. Upper Burl. limest. Subcarb. Burlington, Iowa.
1860. Pot. (Scaphioer.) *divaricatus* Hall. Supp. Geol. Rep. Iowa, p. 65. Warsaw limest. Subcarb. Illinois and Indiana.
1858. Pot. (Scaphioer.) *dichotomus* Hall. (Type of *Scaphioerinus*, as proposed by us.) Geol. Rep. Iowa, vol. i. pt. ii. p. 553. Upper Burl. limest. Subcarb. Burlington, Iowa.
1873. Pot. (Scaphioer.) *Huntsville* Worthen. Geol. Rep. Ill., vol. v. p. 534, pl. 20, fig. 1. St. Louis limest. Subcarb. Huntsville, Ala.
- *1860. Pot. (Scaphioer.) *Keokuk* Hall. (Poterioer. *Keokuk*.) Supp. Geol. Rep. Iowa, p. 64. Keokuk limest. Subcarb. Keokuk Iowa.
1858. Pot. (Scaphioer.) *internodius* Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 679, pl. 25, fig. 2. Chester limest. Subcarb. Chester, Ill.
- *1843. Pot. (Scaphioer.) *isacobus* Austin. (Poterioer. *isacobus*.) Ann. and Mag. Nat. Hist., vol. ii p. 195. Mon. Rec. and Foss. Crin., p. 74, pl. 8, fig. 4 a, b. Subcarb. England and Ireland.
1869. Pot. (Scaphioer.) *nanus* Meek & Worthen (not *Poterioer. nanus*, Ad. Reemer, 1868 = *Homocrinus nanus*). Proc. Acad. Nat. Sci. Phila., p. 141; Geol. Rep. Ill., vol. v. p. 423, pl. 1, fig. 8. Lower Burl. limest. Subcarb. Burlington, Iowa.
1869. Pot. (Scaphioer.) *penicillus* Meek & Worth. Proc. Acad. Nat. Sci. Phila., p. 142. Geol. Rep. Ill., vol. v. p. 414, pl. 2, fig. 7. Upper Burl. limest. Subcarb. Burlington, Iowa.
- *1867. Pot. (Scaphioer.) *pusillus* Trantschold (*Hydrioncrinus pusillus*). Bull. de la Soc. Imp. des Naturalists de Moscou, p. 16, pl. ii. fig. 9; Quenstedt. Petrefact. Deutschlands, iv. p. 537, pl. 106, fig. 47. Trantschold, 1879. Kalkbrüche von Mjatschkowa, p. 116, pl. 14, fig. 4, and pl. 15, fig. 2. Upper Subcarb. Near Moscow, Russia.
1861. Pot. (Scaphioer.) *ramulosus* Hall. Bost. Journ. Nat. Hist., p. 307. Upper Burl. limest. Subcarb. Burlington, Iowa.
1873. Pot. (Scaphioer.) *Randolphensis* Worthen. Geol. Rep. Ill., vol. v. p. 551, pl. 21, fig. 14. Chester limest. Subcarb. Chester, Ill.
1863. Pot. (Scaphioer.) *rusticellus* Worth. Bost. Journ. Nat. Hist., p. 595. Foss.

short and infolding arms and in the concavity of its basal portions; but it differs from both in the construction of the ventral sac, which in this group is almost cylindrical, with a tendency toward a balloon shape.

- 1873. *Poteriocrinus* (*Pachylocrinus*) *arboreus* Worthen (*Zeacrinus arboreus*).
Geol. Rep. Ill., vol. v. p. 534, pl. 20, fig. 5. St. Louis limest. Subcarb.
Huntsville, Ala.
- 1862 *Pot. Pachylocr.* *asper* Meek & Worthen. (*Zeacr. asper*). Proc. Acad.
Nat. Sci. Phil., p. 150; Geol. Rep. Ill., vol. v. p. 430, pl. 1, fig. 7. Burl.
limest. Subcarb. Burlington, Iowa.
- 1870 *Pot. (Pachylocr.) concinnus* Meek & Worthen. (*Pot. (Zeacr.) concinnus*).
Proc. Acad. Nat. Sci. Phil., p. 26, Geol. Rep. Ill., vol. v. p. 490, pl. 14,
fig. 3. Keokuk limest. Subcarb. Crawfordsville, Ind.
- 1843 (?) *Pot. Pachylocr.* *latifrons* Austin. Rec. and Foss. Crin., p. 82, pl. 10,
fig. 4. Subcarb. England (closely resembling *Zeacrinus*).
- 1869 *Pot. (Pachylocr.) liliiformis* Meek & Worthen. Described June, 1861, un-
der *Pot. carinatus* M. & W. (not *Scaphiocr. carinatus* Hall, February,
1861), Proc. Acad. Nat. Sci. Phil., p. 139, *Scaphiocr. carinatus* M. & W.,
1868, Geol. Rep. Ill., vol. iii. p. 486, pl. 17, fig. 1. *Scaphiocr. liliiformis*,
1869, Proc. Acad. Nat. Sci. Phil., p. 138. Upper Burl. limest. Subcarb.
Burlington, Iowa.
- 1864. *Pot. (Pachylocr.) merope* Hall. (*Zeacr. merope*). 17th Rep. N. Y. St.
Cab., p. 60. Geol. Rep. Ohio, Pal., vol. ii. p. 178, pl. 12, fig. 18. Waverly
Gr. Subcarb. Richfield, Ohio.
- 1864. *Pot. (Pachylocr.) paternus* Hall. (*Zeacr. paternus*). 17th Rep. N. Y.
St. Cab., p. 59, Geol. Rep. Ohio, Pal., vol. ii. p. 177, pl. 12, fig. 17. Waverly
Gr. Subcarb. Richfield, Ohio.
- 1862 *Pot. (Pachylocr.) perangulatus* White. (*Zeacr. perangulatus*). Proc.
Bost. Soc. Nat. Hist., vol. ix. p. 11. Upper Burl. limest. Subcarb. Bur-
lington, Iowa.
- 1860 *Pot. Pachylocr.* *planobrachiatus* Meek & Worthen. (*Zeacr. planobra-
chiatus*). Proc. Acad. Nat. Sci. Phil., p. 391. Geol. Rep. Ill., vol. ii. p.
240, pl. 18, fig. 5. Keokuk limest. Subcarb. Monroe Co., Ill.
- 1879 *Pot. (Pachylocr.) subaequalis* Wachsm. & Springer. Type of the group.
Described by Hall, 1861, as *Scaphiocr. aequalis* (not *Pot. (Scaphiocr.) aequalis*
Hall, 1859). Desc. New Pal. Crin., p. 8, Bost. Jour. Nat. Hist., p. 316,
Meek & Worthen, 1873, Geol. Rep. Ill., vol. v. pl. 15, fig. 6. Keokuk limest.
Subcarb. Crawfordsville, Ind.

E. SCYTALOCRINUS W. & Spr.

(*scutaly* a staff or club; *apion* a lily.)

General form of body, including arms, very slender and almost cylindrical. Calyx obconical or bell shaped. Underbasals well developed and bent upward; radials and brachials of nearly the same form, with straight hinge line occupying the entire width of the plates; brachials either single or compound, and supporting

C. PARISOOCRINUS W. & Spr.

(ωάπιστος resembling, αἶψα a lily.)

Calyx obconical. Differs from the last group in having two or more brachials, which are short and rest within a small semicircular scar. Mode of articulation and branching of arms almost as in *Cyathocrinus*. Column round, rarely pentangular.

1858. *Poteriocrinus* (*Parisoocrinus*) *curtus* Müller. Verh. d. nat. Verein f. Rheinl., xli. p. 80, pl. 10, figs. 2, 3. Neue Rhein. Eid. Kalk., p. 230, pl. 2, fig. 3; Schultz, 1866, Rhein. Eid. Kalk. p. 46, pl. 5, fig. 5. Devonian. Elbel, Germany.
- *1858. Pot. (*Parisoocr.*) *intermedius* Hall (*Cyathocr. intermedius*). Geol. Rep. Iowa, vol. i. pt. ii. p. 627, pl. 18, fig. 10. Keokuk limest. Subcarb. Warsaw, Ill.
1861. Pot. (*Parisoocr.*) *nerens* Hall. 15th Rep. N. Y. St. Cab., p. 121. Hamilton Gr. Devonian. Ontario Co., New York.
1869. Pot. (*Parisoocr.*) *perplexus* Meek & Worthen. Type of this group (*Poteriocr. (?) perplexus*). Proc. Acad. Nat. Sci. Phila., p. 138. Geol. Rep. Ill., vol. v. p. 405, pl. 2, fig. 13. Lower Burl. limest. Subcarb. Burlington, Iowa.
1821. Pot. (*Parisoocr. (?)*) *quinquangularis* Miller (*Cyathocr. quinquangularis*). A History of the Crinoidea, p. 92, with figures. *Poteriocrinus* Austin, 1843 Ann. and Mag. Nat. Hist., vol. 10, p. 108, and vol. 11, p. 196. Rec. and Foss. Crin., pl. 10, figs. 2 a-e. Subcarb. England and Ireland.
1843. Pot. (*Parisoocr.*) *radiatus* Austin. Ann. and Mag. Nat. Hist., vol. 10, p. 108, and vol. 11, p. 196. Rec. and Foss. Crin., p. 79, pl. 10, figs. 1 a, b. Subcarb. Ireland, England, and Belgium.
1862. Pot. (*Parisoocr.*) *salignoides* White. Proc. Bost. Soc. Nat. Hist., p. 16. Upper Burl. limest. Subcarb. Burlington, Iowa.
1861. Pot. (*Parisoocr.*) *tenulbrachiatus* Meek & Worthen. Proc. Acad. Nat. Hist. Phila., p. 138. Geol. Rep. Ill., vol. iii. p. 485, pt. 16, fig. 1. Upper Burl. limest. Subcarb. Burlington, Iowa.

- 1861. *Pot. (Seytaloocr.) robustus* Hall. Desor. New Pal. Crin., p. 7. Bost. Jour. Nat. Hist., p. 315. Keokuk limest. Subcarb. Crawfordsville, Ind.
- *Syn. Poteriocr. Hoveyi* Worthen. Geol. Rep. Ill., vol. vi. p. 516, pl. 29, fig. 6.
- 1843. *Pot. (Seytaloocr.) rostratus* Austin. Ann. and Mag. Nat. Hist., vol. x. p. 108; vol. xi. p. 196; Rec. and Foss. Crin., p. 75, pl. 9, figs. 2 a-f. Mountain limest. Subcarb. England, Ireland.
1879. *Pot. (Seytaloocr.) Wetherbeyi* Miller. Cincinnati Soc. Nat. Hist. (April number), p. 6, pl. 8, figs. 1, 1 a, b. Chester limest. Subcarb. Kentucky.

b. Species with a Compound Brachial.

1867. *Pot. (Seytaloocr.) bijugus* Trautschold. Bull. Soc. Natur. de Moscou, p. 14, pl. 4, fig. 1-3. 1879. Kalkbrüche von Mjatschkowa, p. 114, pl. 14, fig. 3. Upper Subcarb. Moscow, Russia.
- *1879. *Pot. (Seytaloocr.) grandis* Wachsm. & Spr. Described as *Poteriocr. Coreyi* Worthen, 1875. Geol. Rep. Ill., vol. vi. p. 516, pl. 29, figs. 2, 3 (not *Pot. (Scaphiocr.) Coreyi* M. & W. 1869). Keokuk limest. Subcarb. Crawfordsville, Ind.
- *1867. (?) *Pot. (Seytaloocr.) originarius* Trautschold. Bull. Soc. Nat. de Moscou, p. 2, pl. 1, fig. 1. Kalkbrüche bei Mjatschkowa, p. 110, pl. 14, fig. 1. Upper Subcarb. Near Moscow, Russia.

We cannot believe that this species possesses only six arms as described by its author, as this would be too great a departure from the arm structure of Crinoids generally. It may possibly have had nine arms, with a single one in the anterior ray, but more probably ten. Thus far but a single specimen has been discovered, and in this only the right posterior ray is perfectly visible, which had two arms; the two adjoining rays are partly hidden from view, while the remaining two are entirely imbedded in the matrix. There are traces of but five arms in the slab. We judge from the photograph, Pl. 14, fig. 1, that the arrangement of the plates in the calyx has been somewhat disturbed, and this explains the fact that in the diagram, p. 110, the basals (subradials of Trautschold) and radials are incorrectly represented. It may, however, be possible that the original, like a specimen of *P. bijugus* in our possession, for which we are indebted to the kindness of Prof. Trautschold, is abnormal, and that some of the basals (subradials) are anchylosed with the adjoining radials, as in our specimen. Until better material is found we must consider *P. originarius* as a large and abnormal example of *P. bijugus*.

- *1879. *Pot. (Seytaloocr.) urna* Trautschold. (*Phialocr. urna*). Steinbrüche von Mjatschkowa, p. 123, pl. 15, fig. 5. Upper Subcarb. Near Moscow, Russia. (Compare with our remarks on *Phialocrinus*.)
1875. *Pot. (Seytaloocr.) Van Hornei* Worthen. Geol. Rep. Ill., vol. vi. p. 517, pl. 31, figs. 2, 3. St. Louis limest. Subcarb. St. Louis, Mo.

P. DECAOCCRINUS W. & Spr.

(*ὅλιος*, number of ten; *κρίνον* a lily.)

Arms always ten in number. Calyx depressed. Shallow bowl or saucer-shaped. Underbasals small, frequently hidden from view in the concave base. Form of radials and brachials as in the preceding group, the latter plates simple or compound. Arms composed of angular wedge-form joints, zigzag, with the longer sides alternating and projecting so as to support short rounded pinnulæ, which have the appearance of armlets. Column more or less pentangular.

a. Species with a Single Brachial.

- *1865. *Poteriocrinus* (*Decaoocrinus*) *Bayensis* Meek & Worthen. (*Scaphioocr. Bayensis*.) Proc. Acad. Nat. Sci. Phil., p. 157; Geol. Rep. Ill., vol. v. p. 550, pl. 20, fig. 2. Chester limest. Subcarb. Illinois.
- *1870. *Pot.* (*Decaoocr.*) *depressus* Meek & Worthen. (*Scaphioocr. depressus*.) Proc. Acad. Nat. Sci. Phil., p. 27; Geol. Rep. Ill., vol. v. pl. 14, fig. 3. Keokuk limest. Subcarb. Crawfordville, Ind.
- *1869. *Pot.* (*Decaoocr.*) *foveolus* Meek & Worthen. (*Scaphioocr. foveolus*.) Proc. Acad. Nat. Sci. Phil., p. 141; Geol. Rep. Ill., vol. v. p. 423, pl. 1, fig. 3. Lower Burl. limest. Subcarb. Burlington, Iowa.
- *1861. *Pot.* (*Decaoocr.*) *Halli* Hall. (*Scaphioocr. Halli*.) Desc. New Pal. Crin., p. 7; Bost. Journ. Nat. Hist., p. 308. Upper Burl. limest. Subcarb. Burlington, Iowa.
- *1864. *Pot.* (*Decaoocr.*) *lyriope* Hall. (*Scaphioocr. lyriope*.) 17th Rep. N. Y. St. Cab., p. 58; Geol. Surv. Ohio, Pal., vol. II. p. 175, pl. 12, fig. 10. Waverly Gr. Subcarb. Richfield, Ohio.
- 1864. *Pot.* (*Decaoocr.*) *pleius* Hall. 17th Rep. N. Y. St. Col., p. 141; Geol. Surv. Ohio, Pal., vol. II. p. 173. Waverly Gr. Subcarb. Richfield, Ohio.
- *1869. *Pot.* (*Decaoocr.*) *Stimpsoni* Lyon. (*Zocr. Stimpsoni*.) Trans. Am.



- *1861. *Pot. (Decadocr.) scalaris* Meek & Worthen Type of this group (*Scaphocr. scalaris*) Proc. Acad. Nat. Sci. Phil., p. 145. Geol. Rep. Ill., vol. v. p. 471, pl. 2, fig. 10 Upper Burl. limest. Subcarb. Burlington, Iowa.
- *1864. *Pot. (Decadocr.) subtortuosus* Hall. (*Scaphiocr. subtortuosus*.) 17th Rep. N. Y. St. Cab., p. 59 Geol. Surv. Ohio, Pal., vol. ii. p. 177, pl. 12, figs. 15, 16. Waverly Gr. Subcarb. Richfield, Ohio.

G. Species of *Poteriocrinus*, imperfectly known.

1838. *Poteriocr. calycinus* Hall Geol. Rep. Iowa, vol. i. pl. 2, p. 553, pl. 9, figs. 6 a, 6 b Lower Burl. limest. Subcarb. Burlington, Iowa.
1836. *Poteriocr. conicus* Phillips Geol. Yorksh., ii. pl. 4, fig. 3. Portlock's Geol. Rep., pl. 16, fig. 12 De Koninck, 1842, Animaux Foss., p. 47, pl. F, fig. 3. Milne Edwards ap. Lamarck, p. 664, Austin, 1843, Rec. and Foss. Crin., p. 82, pl. 10, figs. 3 a, b, c. Subcarb. England, Ireland, and Belgium.
1853. *Poteriocr. conoides* De Koninck & Lehon Recherch. Crin. Belg., p. 93, pl. 1 figs. 5 a, b Subcarb. Visé, Belgium.
1869. (?) *Poteriocr. cylindricus* Lyon (Not Hall = *Homocr. cylindricus*). Trans. Am. Philos. Soc., Philad., vol. xiii. p. 458, pl. 27, fig. 1. Enocrinal limest. Subcarb. Falls of the Ohio. (Imperfect specimen.)
1842. *Poteriocr. gracilis* McCoy (Not *Pot. gracilis* Hall = *Dendocr. gracilis*.) Carb. Foss. Ireland, p. 178, pl. 25, figs. 11-14. Subcarb. Ireland.
1873. *Poteriocr. Hardinensis* Worthen Geol. Rep. Ill., vol. v. p. 533, pl. 20, fig. 10 St. Louis limest. Subcarb. Hardin Co., Ill.
1836. *Poteriocr. impressus* Phillips Geol. Yorksh., ii. p. 205, pl. iv. fig. 1, Austin, 1843, Rec. and Foss. Crin., pl. 10, fig. 6. (Not *Pot. impressus* Richter & Unger Geognost. Rossion, 1860, pl. 31, fig. 46.) Subcarb. England.
1861. *Poteriocr. indentus* Hall 15th Rep. N. Y. St. Cab., p. 122. Hamilton Gr. Devonian. Ontario Co., N. Y.
- *1861. *Poteriocr. leviculus* Lyon (*Cyathocr. leviculus*.) Proc. Acad. Nat. Sci. Phil. p. 409. Enocrinal limest. Subcarb. Jefferson Co., Ky.
1873. *Poteriocr. Lasallensis* Worthen Geol. Rep. Ill., vol. vi. p. 526, pl. 32, fig. 3 Upper Coal Measures. LaSalle, Ill.
1861. *Poteriocr. lepidus* Hall Desc. New Pal. Crin., p. 6, Bost. Journ. Nat. Hist., p. 304 Lower Burl. limest. Subcarb. Burlington, Iowa.
1873. *Poteriocr. macoupiensis* Worthen Geol. Rep. Ill., vol. v. p. 561, pl. 24, fig. 3 Coal Measures, Ill.
1850. *Poteriocr. minutus* F. A. Roemer Beitr. zur Kenntn. d. Harsgeb., p. 47, pl. 8 figs. 1 a-d Posidonien Schiefer Devonian. Lauthenthal, Germany.
1872. *Poteriocr. montanaensis* Meek Hayden's Rep. U. S. Geol. Surv. Terr. Lower Carbon. Montana Territory.
1861. *Poteriocr. nassa* Hall 15th Rep. N. Y. St. Cab., p. 120 Hamilton Gr. Devonian. Canandaigua, N. Y.
1861. *Poteriocr. nereus* Hall 15th Rep. N. Y. St. Cab., p. 121. Hamilton Gr. Devonian. Ontario Co., N. Y.
1861. *Poteriocr. nodebrachiatus* Hall Desc. New Pal. Crin., p. 8, Bost. Journ. Nat. Hist., p. 314 Keokuk limest. Subcarb. Crawfordville, Ind.
1838. (?) *Poteriocr. pachydactylus* Muller Monatsber. Berl. Acad., p. 192. Devonian. Germany. (No means of comparison.)
1838. (?) *Poteriocr. patulus* Muller. Monatsber. Berl. Acad. Devonian. Germany. (No means of comparison.)

1843. *Poterioer. pentagonus* Austin. (*Cladoer. pentagonus*.) Ann. & Mag. Nat. Hist., vol. ii. p. 198; Rec. and Foss. Crin., p. 86, pl. 11. figs. 2 a-f. Subcarb. England.
1858. *Poterioer. rugosus* Shumard. Trans. St. Louis Acad. Sci. Coal Measures. (No means of comparison.)
1869. *Poterioer. simplex* Lyon. (Not Pot. (*Scaphioer.*) *simplex* Hall=*Graphioer. simplex*.) Trans. Am. Philos. Soc. Phil., p. 458, pl. 26, fig. f. Upper Helderberg, Devonian. Falls of the Ohio.
1821. *Poterioer. tenuis* Miller. Hist. Crin., p. 71; Schlotheim, 1823; Nachtr. Petrefactenk., vol. ii. pl. 25, fig. 2; Austin, 1843, Rec. and Foss. Crin., p. 83, pl. 10, figs. 5 a, b. Mountain limest. Subcarb. England and Ireland.
- *1861. *Poterioer. Wortheni* Lyon. (*Cyathor. Wortheni*.) Proc. Acad. Nat. Sci. Phil., p. 410. Encrial limest. Devon. Jefferson Co., Ky.

15. *GRAPHIOCRINUS* De Koninck & Lehon.

1858. *Graphiocrinus* De Kon. & Leh. Crin. Carb. Belg., p. 115.
1858. *Scaphiocrinus* (in part) Hall. Geol. Rep. Iowa, vol. i. pt. 2, p. 549.
1879. *Phialocrinus*(?) Trautschold. Kalkbrüche Mjatch., p. 129.

A. Typical form.

In general aspect *Graphiocrinus* closely agrees with a form of *Poteriocrinus* for which we have proposed the name *Scytalocrinus*, from which, however, it differs clearly in the anal area, which in *Graphiocrinus* has but a single plate, while in the other it has three. De Koninck, in his generic description, mentions only two orders of plates as constituting the calyx, in which he is evidently mistaken. We have before us several species from the Burlington limestone, which have heretofore been referred by their authors to *Scaphiocrinus*, but which agree in the clearest manner with the typical *Graphiocrinus encrinurus*. They all, like the typical spe-

last named, that the entire genus *Scaphiocrinus* as formulated by Hall, is identical with *Graphiocrinus*. *Scaphiocrinus simplex*, and a few other species like it with a single anal plate, are undoubtedly so, but all others, and by far the majority of species described under *Scaphiocrinus*, are generically distinct from *Graphiocrinus*, and must be classed with *Poteriocrinus*.

Closely related to *Graphiocrinus* are *Bursacrinus*, Meek & Worthen, and *Phialocrinus*, Trautschold. We can perceive slight structural differences by which the two might be distinguished from the first, but it can only be a subgeneric division, and it is somewhat questionable whether even this can be maintained as to *Phialocrinus*.

Revised Generic Diagnosis.—General form elongate, almost cylindrical. Calyx small, rather shallow, with bilateral symmetry. Underbasals five, minute, rarely extending beyond the column. Basals small; four at least, frequently all five of them, equal. The former is the case in all species in which the anal plate is disconnected from the basals, the latter when it rests directly upon one of them, in which case the posterior basal is considerably higher and truncate above. Radials large, their upper articulating margins straight. Brachials one by five, as large or larger than the radials, and of a similar form, but with the lower margin straight; sutures gaping, articulating facet occupying the entire width of the plate.

There are generally two arms to each brachial, or ten to the individual, which remain simple throughout; but in the above mentioned species the upper side of the brachials is truncate, and the Crinoid has only five arms. The arms are long and heavy, composed of short joints with almost parallel sutures. Pinnulæ long.

A single rather small anal plate is placed half-way between the radials and brachials, either resting on the posterior basal or separated from it, but in either case extending above the plane of the radials. Ventral sac, so far as observed, strong, composed of elongate hexagonal plates. Column round or obtusely pentagonal.

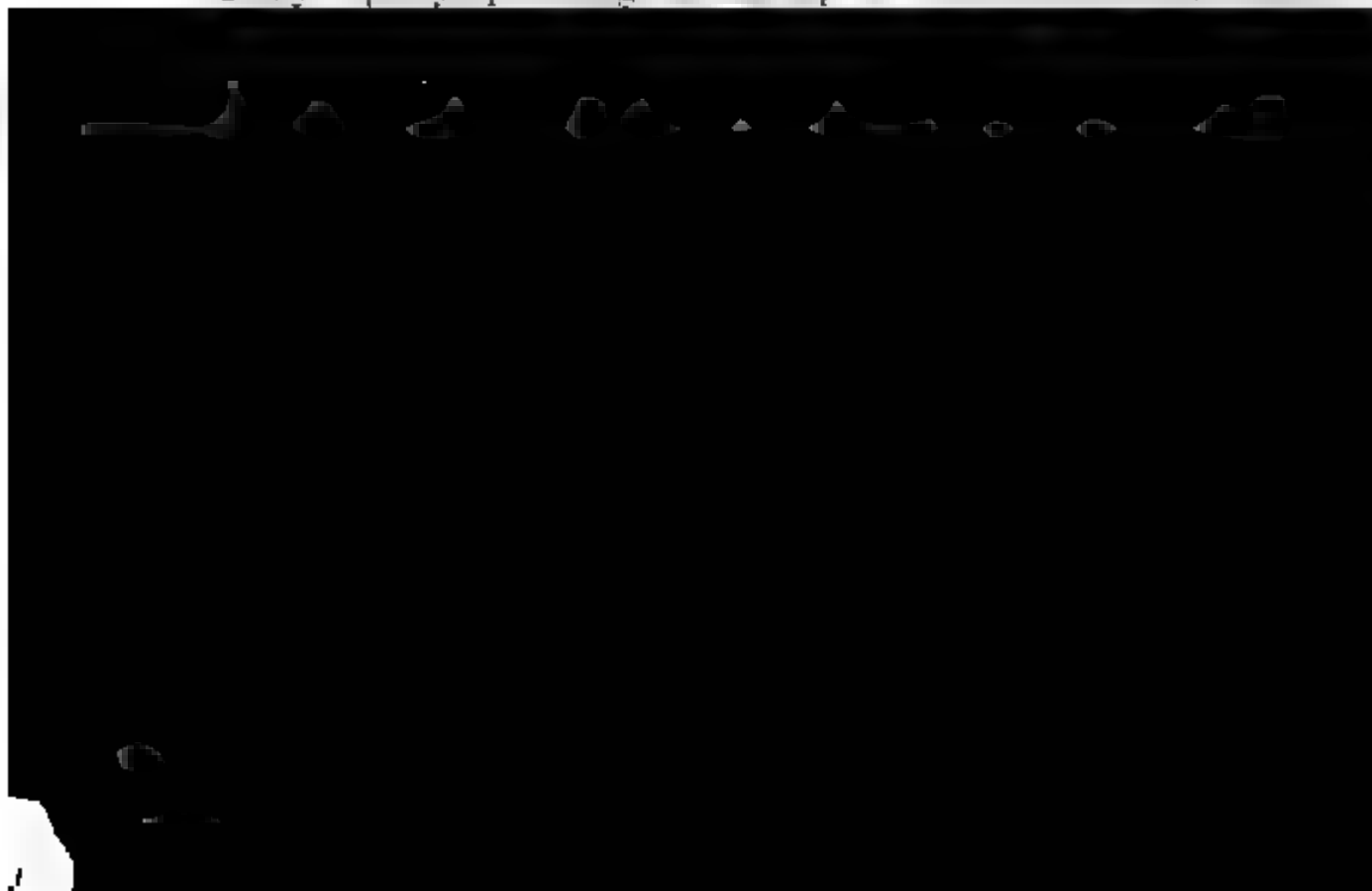
Geological position, etc.—Found so far only in the Subcarboniferous both of Europe and America. We recognize the following species:—

- *1861. † *Graphioerinus carbonarius* Meek & Worthen. (*Scaphioer. carbonarius*.) Proc. Acad. Nat. Sci. Phil., p. 140; Geol. Rep. Ill., vol. v. p. 642, pl. 24, fig. 2. Coal Measures. Springfield, Ill.
1863. *Graphioer. enorinoides* De Koninck & Lehon. Type of the genus. Recherch. Crin. Belg., p. 117, pl. 4, fig. 15, 15 a, b. Mountain limest. Subcarb. Tournay, Belg., and Bristol, Eng.
- *1873. *Graphioer. McAdamsi* Worthen. (*Scaphioer. McAdamsi*.) Geol. Rep. Ill., vol. v. p. 495, pl. 16, fig. 2. Keokuk limest. Subcarb. Jersey Co., Ill.
- *1869. *Graphioer. radis* Meek & Worthen. (*Scaphioer. radis*.) Proc. Acad. Nat. Sci. Phil., p. 139; Geol. Rep. Ill., vol. v. p. 412, pl. 1, fig. 1. Upper Burlington limest. Subcarb. Burlington, Iowa.
- *1858. *Graphioer. simplex* Hall. (*Scaphioer. simplex*.) Geol. Rep. Iowa, vol. 1 pt. ii. p. 651, pl. 9, Fig. 10. Burlington limest. Subcarb. Burlington, Iowa.
- *1861. *Graphioer. spinobrachiatus* Hall. (*Scaphioer. spinobrachiatus*.) New Pal. Crin., p. 8; Bost. Journ. Nat. Hist., p. 306. Lower Burlington limest. Subcarb. Burlington, Iowa.
- *1869. *Graphioer. striatus* Meek & Worthen. (*Scaphioer. striatus*.) Proc. Acad. Nat. Sci. Phil., p. 142; Geol. Rep. Ill., vol. v. pl. 2, fig. 11. Lower Burlington limest. Subcarb. Burlington, Iowa.
- *1861. *Graphioer. tortuosus* Hall. (*Scaphioer. tortuosus*.) Desc. New Pal. Crin., p. 7; Bost. Journ. Nat. Hist., p. 309. Upper and Lower Burlington limest. Subcarb. Burlington, Iowa.
- *1861. *Graphioer. Wachsmuthi* Meek & Worthen. (*Scaphioer. Wachsmuthi*.) Proc. Acad. Nat. Sci. Phil., p. 141; Geol. Rep. Ill., vol. iii., p. 488, pl. 16, fig. 7, a, b. Lower Burl. limest. Subcarb. Burlington, Iowa.

B. Subgenus *BURSACRINUS* Meek & Worthen.

1861. *Bursacrinus* M. & W. Proc. Acad. Nat. Sci. Phil., p. 136.
1862. *Bursacrinus* White. Proc. Bost. Soc. Nat. Hist., vol. ix. p. 11.
1868. *Bursacrinus* M. & W. Geol. Rep. Ill., vol. iii. p. 478.

Body rapidly spreading to the top of the first division of the



arm pieces are less than half the width of the last, and like all others composed of a single series of joints.

In the extraordinary width of the lower portion of the arms, the flatness of the arm pieces, and the fact that these lie side by side, abutting laterally, *Bursacrinus* somewhat resembles *Ichthyocrinus*, but the arms are comparatively longer and the general construction of the body otherwise is very distinct.

Only two species are known; both are from the Subcarboniferous.

1861. *Bursacrinus Wachsmuthi* Meek & Worthen. Type of the subgenus. Proc. Acad. Nat. Sci. Phil., p. 137; Geol. Rep. Ill., vol. iii. p. 479, pl. 17, fig. 6. Upper Burlington limest. Subcarb. Burlington, Iowa.
1862. *Bursacrinus confirmatus* White. Proc. Bost. Soc. Nat. Hist., vol. ix. p. 11. Lower Burlington limest. Subcarb. Burlington, Iowa.

C. Subgenus (?) **PHIALOCRINUS** Trautschold.¹ (Not Eichwald)

1879. Monogr. Kalkbrüche von Mjatschkowa, p. 122.

Prof. Trautschold proposed the above name in a full generic sense for two species of Crinoids from the Upper Subcarboniferous of Russia. The resemblance to *Graphiocrinus*, as already mentioned, is so close that we doubt whether the group can be upheld even subgenerically. So far as known, *Phialocrinus patens* differs from *Graphiocrinus*, as now revised, only in having two brachial pieces instead of one, and in the underbasals, which here project slightly beyond the column. The latter is unimportant, and a comparison will show that the two brachials combined have exactly the form of the single plate in *Graphiocrinus*; their division involves no structural change, but merely facilitates articulation. Trautschold's first species only can be placed here: his *P. urna* is certainly a *Poteriocrinus*, as indicated by its obconical form, the large underbasals, and especially by the arrangement of its anal plates.

1879. *Graphiocr. (Phialocrinus) patens* Trautschold. Monogr. d. Kalkbrüche von Mjatsch., p. 123, pl. 15, fig. 4. Upper Subcarb. Near Moscow, Russia.

16. **WOODOCRINUS** De Koninck.

1854. Recherch. Crin. Belgique. Supplement, p. 4.

General form including arms short and robust; calyx depressed, arrangement of the plates in the anal area unsymmetrical.

Underbasals five; small, quadrangular, forming a pentagon

¹ Eichwald's genus *Phialocrinus* (*Lethaea Rossica*, i. p. 578, pl. 31, fig. 27) was not defined, being founded on fragmentary pieces of column.

with nearly straight sides, slightly concave in the middle. Basals about of equal size, hexagonal, wider than high. Radials pentagonal, wide, and short, broadly truncate above. Brachials one by five, similar in form to the radials, but truncate below instead of above; they support on each upper sloping side an arm which bifurcates on the fourth to the eighth plate above, the branches remaining simple throughout, thus giving four arms to each ray uniformly.

The arms are rather divergent, heavy, rounded on the outside, gently tapering to the tips and terminating in a sharp point. Arm pieces extremely short, their sutures parallel. Pinnulae long and numerous, directed inward, composed of ten to twelve small joints.

The anal area is remarkable for its great number of pieces, being composed longitudinally of several rows of plates, alternately arranged. The lower and largest plate rests between two basals, one of the upper sides against the right posterior radial, the other against the first anal of the adjoining row. The second anal plate rests upon a basal, and abuts laterally against the left posterior radial. The third anal is placed upon the first, toward the right side of the second, and rests partly against the right posterior radial. The anal area is elliptic in outline, composed of twelve or more plates, only three of which are on a level with the radials. The form of the ventral sac is unknown, but from all appearances it is somewhat balloon-shaped, and does not extend to the top of the arms.

Column rather slender composed of alternate wider and nar-

1860. *Zeacrinus* Meek & Worthen. Subgenus of *Potarioerinus*. Geol. Rep. Ill., vol. ii. p. 186. (Not *Zeacrinus* Schultze. Monog. Echin. Eifel Kalk., p. 38.)

General form of body with arms closed, terete or subcylindrical, often contracted near the arm bases and spreading above; Calyx more or less depressed, low cup or basin-shaped, rarely turbinate, with the basal portion sunken in and forming a deep concavity. Arrangement of plates slightly unsymmetrical.

Underbasals five (abnormally six), small, generally hidden in the central concavity, and covered by the column. Basals five, sometimes nearly equal, but more frequently showing a tendency to irregularity on the posterior side. Radials five, pentagonal, the upper side truncate, with a single brachial plate in each of the four lateral rays; the anterior ray, however, as a rule has one, two, to six or more additional quadrangular brachials, and a bifurcating plate above, resembling in outline the single brachial of the other rays. The latter plate is wide, rather short, and of the form of the radials, but truncate below, and joining the entire upper margin of the radial.

Arms comparatively short, bifurcating, scarcely rounded on the exterior, rarely angular; the bifurcating plates comparatively larger and sometimes nodose. Ramifications only occur on the two outer arms of the rays, and these arms have straight outer margins throughout their length. The branches are given off at regular intervals toward the inner side of the ray, and remain single throughout. The arms are all of uniform thickness, and their sides are sharply defined, and when closed they join so neatly with each other that it appears as if they formed a solid body. Arm-joints much wider than long, with nearly parallel sutures. Pinnulae short and slender, composed of six or more angular joints directed to the interior of the erinoid, not given off laterally. Arm furrows apparently covered by the infolding of the pinnulae, not by alternating plates.

There are from five to seven anal plates, alternately arranged in two rows, the lower plate resting with one side against the sloping right side of the posterior basal, the other against the right posterior radial, in some species almost touching the underbasals. The arrangement of the succeeding plates is very similar to that of *Wunderlinus*, except that the portion of the anal area above the line of the radials has a sharp triangular outline instead of

elliptic as in that genus. The whole protrudes and is almost even with the surface of the adjoining arms, which curve around it or rest upon its flanks. The ventral sac is broadly balloon-shaped, and extends, so far as observed, to about one-half the height of the arm. It is composed of a great number of small plates, is subpyramidal, sharply pointed at its upper end. It consists of five diverging spheromeres, the radial portions deeply depressed, the interr radial extending outward in sharp edges, the edge at the posterior side connecting with the anal area, those of the other sides abruptly turned near the top of the calyx toward the posterior of the specimen, where the sac evidently connects with the main body, thus resembling a balloon. The sharp edges are wedged in for a short distance between the outer arms of two different rays, and the arms themselves with their pinnulæ rest within the radial excavations almost as in *Eucalyptocrinus*. The radial spaces are subdivided near their base by a short ridge, underneath which, and apparently independent of the sac, there is seen in every ray a little short tube representing the ambulacral passages. There is no sign of an anal opening, but we have observed two rows of respiratory pores along the median line of the radial depressions.

Column round, sometimes bordered by irregular lateral cirrhi; its diameter small, the central canal minute and apparently round.

The genus *Zeacrinus* is evidently closely related to *Woodocrinus*, and as we are inclined to believe that the ventral sac, which has not yet been discovered in the latter, is most probably similarly constructed, we have felt, almost like *Zeacrinus*

defined. The ventral sac, which really presents the best generic characters, and by which it is easily recognized, was altogether unknown, and the difficulty was increased when several species were admitted which belong to other groups, and which were evidently not intended to be included by the authors of the genus. We have been obliged to throw out all species with long, angular, angular arm-joints; these have also a tubular ventral sac, and we have placed them under some of the varieties of *Poteriocrinus*, where they really belong.

Zeacrinus has by most authors been placed under *Poteriocrinus* as a subgenus, but in this we cannot concur. We look upon it rather as the type of an independent little group of Crinoids, including several genera, which culminates in *Hydreionocrinus* and *Oculocrinus*, some of the last survivors of the Cyathocrinidæ.

Zeacrinus excavatus Schultze is evidently a *Taxocrinus*.

Geological position, etc.—The genus is confined to the Subcarboniferous, ranging through all the divisions of that epoch; and has only been discovered in America.

We recognize the following species:—

1869. *Zeacrinus asper* Meek and Worthen. Proc. Acad. Nat. Sci. Phila., p. 150. Geol. Rep. Ill., vol. v. p. 430, pl. 1, fig. 7. Lower Burlington limestone. (not Upper Burlington l. as stated by M. and W.). Subcarb. Burlington, Iowa.
1869. *Zeacr. bifurcatus* McChesney. New Pal. Foss., p. 10. Trans. Chicago Acad., 1867, vol. i. p. 71, pl. 4, fig. 3. Chester limestone. Subcarb. Chester, Ill.
1862. *Zeacr. bursæformis* White. (*Poteriocr. bursæformis*.) Proc. Bost. Soc. Nat. Hist., p. 10. Lower Burlington limestone. Subcarb. Burlington, Iowa.
1872. *Zeacr. compactilis* Worthen. Geol. Rep. Ill., vol. v. p. 536, pl. 21, fig. 5. Subcarb. Cumberland Co., Ky.
1888. *Zeacr. elegans* Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 547, pl. 9, figs. 1 and 2. Upper Burlington limestone. Subcarb. Burlington, Iowa.
1847. (?) *Zeacr. florealis* Yandell and Shumard. (*Cyathocr. florealis*.) Cont. Geol. Kentucky, p. 24, pl. 1, fig. 1. Shumard, 1855. *Poteriocr. florealis*, Second Rep. Geol. Missouri, pl. ii. p. 217. Shumard, 1866. *Zeacr. florealis*, Cat. Pal. Foss., pt. i., Echinodermata, p. 399. Chester limestone. Subcarb. Grayson Co., Ky.

We are not certain that this species belongs here, as we have never seen the description.

1858. *Zeacr. intermedius* Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 681, pl. 25, fig. 4. Chester limestone. Subcarb. Chester, Ill.
1846. *Zeacr. magnoliæformis* Owen and Norwood. Type of the genus. (*Cyathocr. magnoliæformis*.) Research Pot. Carb. Rocks, Kentucky. Troost, 1850. *Zeacr. magnoliæformis*, Cat. Crin. Tenn. Hall, 1858, Geol. Rep. Iowa, vol. i. pt. ii. p. 543 and 684, pl. 25, fig. 4. Chester limestone. Subcarb. Grayson Co., Ky.

1859. *Zenar. ovalis* Lyon and Casseday. Am. Jour. Sci. (n. s.) vol. 29, p. 71. Chester limest. Subcarb. Ky.
1858. *Zenar. ramosus* Hall. Geol. Rep. Iowa, vol. i, pt. ii. p. 548, pl. 9, fig. 2. Upper Burl. limest. Subcarb. Burlington, Iowa.
1869. *Zenar. scobina* Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 149; Geol. Rep. Ill., vol. v. p. 426, pl. 1, fig. 2. Upper Burlington limest. Subcarb. Burlington, Iowa.
1869. *Zenar. serratus* Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 151; Geol. Rep. Ill., vol. v. p. 428, pl. 1, fig. 6. Upper Burlington limest. Subcarb. Burlington, Iowa.
1864. (Sept.) *Zenar. Troostanus* Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 390; Geol. Rep. Ill., vol. ii. p. 186, pl. 16, fig. 2. Upper and Lower Burlington limest. Subcarb. Burlington, Iowa.
- (Syn.) *Zenar. scoparius* Hall (Feb. 1861). Descr. New. Pal. Crin., p. 8; Bost. Jour. Nat. Hist., p. 305.
- (Syn.) *Zenar. unculus* White (1862). Proc. Bost. Soc. Nat. Hist., p. 12.
1858. *Zenar. wortheni* Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 683. Chester limest. Subcarb. Chester, Ill.

(Compare with *Z. magnoliaeformis*.)

18. HYDREIONOCRINUS De Koninck.

1858. Bull. Acad. Royale Belgique, vol. viii. pt. ii. p. 18.

A. Typical form.

General form subcylindrical, short, slightly spreading toward the tips of the arms; with an enormous ventral sac extending beyond the limits of the arms, and covering them like a roof. Calyx short, rounded below, basal portion sometimes deeply

Underbasals small, and, according to De Koninck, forming a

: support on their upper sloping sides two arms, which subdivide once, or oftener.

The arms ramify in the same manner as in *Zeacrinus*, by throwing off branches toward the inner side of the ray; they touch laterally, and are so arranged that the sutures between the rays, from the basals up, form straight lines, except on the posterior side where the arms curve slightly, following the margin of the anal area. The arms, before they become simple, are composed of short, strongly wedge-shaped joints alternately arranged, which in most species are by degrees turned into a double series of interlocking plates. Pinnulæ very small and short.

The arrangement of the anal plates is exactly as in *Zeacrinus* and *Woodocrinus*, but the anal area is less protuberant. The ventral sac, which is the most remarkable part of this Crinoid, and the best character for distinction, has the form of a mushroom, upright, cylindrical below, abruptly spreading beyond the tips of the arms and forming a rim composed of a row of 6, 11, 15 or more large, spiniferous or nodose plates, spread out horizontally and tending slightly downward. The upper part or roof is low hemispherical, and is formed either by the spiniferous plates themselves, which are in that case unusually large, or more frequently by a number of irregular plates within the centre. The tube, or cylindrical portion of the sac, is composed of small plates, horizontally arranged, and provided at the sutures with one or two rows of respiratory pores. No other aperture has as yet been observed, nor has the connection of the tube with the main body been ascertained.

Column small.

De Koninck, in his generic description, took the upper portion of the ventral sac to be a regular vault, and thereby distinguished this genus from *Poteriocrinus* with a large proboscis, while this organ, as he supposed, was absent in *Hydreionocrinus*. Some of the European species which De Koninck refers to his genus must be considered doubtful until better proof is given that they belong here. His *H. globularis* is, in our opinion, an *Eupachycrinus*.

Hydreionocrinus has the closest relations with *Zeacrinus*, with which it agrees in the construction of the calyx, and in the mode of bifurcation of the arms; but the enormous size of the ventral sac, its peculiar form and construction, seem to warrant a full generic separation.

Geological position, etc.—The genus is known only from the uppermost part of the Subcarboniferous and from the Coal measures, and occurs both in Europe and America.

We recognize the following species:—

- *1870. *Hydreionocrinus acanthophorus* Meek and Worthen. (*Zenar. Hydreionocr. acanthophorus.*) Proc. Acad. Nat. Sci. Phil., p. 28; Geol. Surv. Ill., vol. v. p. 563, pl. 24, fig. 11. Upper Coal Measures. Illinois and Iowa.
- *1870. *Hydreionocr. armiger* Meek and Worthen. (*Zenar. (?) armiger.*) Proc. Acad. Nat. Sci. Phil., p. 27; Geol. Rep. Ill., p. 547, pl. 21, fig. 3. Chester limest. Subcarb. Pope Co., Ill.
- *1860. *Hydreionocr. depressus* Troost. (*Zenar. depressus.*) Cat. Pal. Foss. Tenn.; Hall, 1858, Geol. Rep. Iowa, vol. i. pt. ii. p. 546. Chester limest. Subcarb. Kentucky and Alabama.
- *1860. *Hydreionocr. discus* Meek and Worthen. (*Zenar. discus.*) Proc. Acad. Nat. Sci. Phil., p. 390; Geol. Rep. Ill., vol. II. p. 312, pl. 26, figs. 3 a, b. Upper Coal Measures. Illinois.

(Compare with *Hydreionocr. acanthophorus.*)

- *1859. *Hydreionocr. mucrospinus* McChesney. (*Zenar. mucrospinus.*) Desc. New Pal. Foss. p. 10; Trans. Chic. Acad. Sci., 1867, vol. i. p. 7, pl. 4, fig. 1. Coal Measures. Illinois.
- 1858. *Hydreionocr. woodianus* De Koninck. Type of the genus. Bull. Acad. Royale Belgique, pt. ii. p. 17, pl. 2, figs. 5, 5 a. Subcarboniferous. Richmond, Yorkshire, England.

Doubtful Species, placed under the genus by De Koninck. Bull. Acad. Royale, Belg., vol. iii. pt. ii. p. 13.

- 1853. (?) *Hydreionocr. calyx* De Koninck and Lehen. (*Zenar. calyx.*) Recherch. Crin. Carb. Belg., p. 90, pl. 1, fig. 6 a-d. Lower Carboniferous. England and Belgium
- 1836. (?) *Hydreionocr. granulosus* Phillips. (*Poterioer. granulosus.*) Geol.

When Dr. White proposed the genus *Cœliocrinus*, he had evidently overlooked De Koninck's genus *Hydreionocrinus*, with which it agrees in all essential points except in the form of the ventral sac, which is balloon-shaped in *Cœliocrinus*, instead of like a mushroom, and except also that in *Hydreionocrinus* the calyx is comparatively larger and the arms shorter. Whether these differences are of sufficient importance to justify even a subgeneric division, is to us somewhat doubtful. The two forms are certainly not generically distinct, for they shade into one another so closely that in some species it becomes difficult even to separate them on the above characters. We, for our part, are inclined to recognize in *Cœliocrinus*, which occurs in the lower Subcarboniferous, the earlier stage of *Hydreionocrinus*; the latter, which flourished during the later periods of the Carboniferous, both in Europe and America, representing the culmination of the form in maturity and extravagance, as developed in the course of time. Such extraordinary development in certain parts of the animal—as here in the ventral sac—frequently occurs when a genus is about to become extinct, and *Hydreionocrinus* is, in fact, one of the last survivors of this family. Bearing this in mind, it is of little consequence whether we place the species of this group under *Hydreionocrinus*, or subgenerically under *Cœliocrinus*.

The relations of this form with *Zeacrinus* are also very close and interesting, and the question may well be asked whether all three forms ought not to be placed under *Woodocrinus*, provided this genus possesses an inflated sac, which we consider the most characteristic feature of this little group; especially as they further agree in the shortness of the arms and their peculiar mode of bifurcation. Such a classification would certainly be more natural than to place them under *Poteriocrinus*, as was done by Hall, and subgenerically by Meek and Worthen. All *Poteriocrini* have long arms, and the ventral sac is prolonged into a slender tube. The arms in all species of *Cœliocrinus* are composed of strongly wedge-shaped plates, which almost interlock, as they do completely in most species of *Hydreionocrinus*, while the corresponding joints in *Zeacrinus* and *Woodocrinus* are regularly quadrangular, with parallel sutures.

Geological position, etc.—Found only in the lower part of the Subcarboniferous of America.

The following species may be arranged here, though we rather prefer their consolidation with *Hydreionocrinus*.

1861. *Collocrinus dilatatus* Hall. (*Poterioer. dilatatus*), Descr. New Pal. Crin., p. 6; Bost. Journ. Nat. Hist., p. 300. White, 1863, *Calioer. dilatatus*, Bost. Journ. Nat. Hist., p. 501. Lower Burlington limest. Subcarb. Burlington, Iowa.
1873. *Colioer. cariniferus* Worthen. (*Zonar. cariniferus*), Geol. Rep. Illinois, vol. v. p. 535, pl. 20, fig. 4. (?) St. Louis limest. Near Huntsville, Ala.
- *1869. *Colioer. lyra* Meek and Worthen. (*Zonar. lyra*), Proceed. Acad. Nat. Sci. Phila., p. 152; Geol. Rep. Illinois, vol. v. p. 432, pl. 1, fig. 11. Upper Burlington limest. Subcarb. Burlington, Iowa.
1863. *Colioer. subapicatus* White. Bost. Journ. Nat. Hist., p. 501. Upper Burlington limest. Subcarb. Burlington, Iowa.
1861. *Colioer. ventricosus* Hall. (*Poterioer. ventricosus*), Descr. New Pal. Crin., p. 6; Bost. Journ. Nat. Hist., p. 301. White, 1863, *Calioer. ventricosus*, Bost. Journ. Nat. Hist., p. 501. Lower Burlington limest. Subcarb. Burlington, Iowa.

19. *EUPACHYCRINUS* Meek and Worthen.

1855. *Eupachycrinus*, Proc. Acad. Nat. Sci. Phila., p. 159.
1866. Geol. Rep. Ill., vol. ii., p. 177.
1867. *Cromyocrinus* Trantschold. Crin. jüng. Bergkalkes bei Moskau, p. 19.
1879. *Cromyocrinus*, Monogr. Kalkbrüche von Mjatschkowa, p. 117.

Meek and Worthen proposed the name *Eupachycrinus*, without generic description, for a small group of American Crinoids, which, by their massive, tumid plates, the double series of interlocking plates generally composing the arms, and their general physiognomy, are well distinguished from all other known genera. They made Lyon's *Graphiocrinus quatuor decimbrachialis* the type of

massive and simple arms, and the exceedingly slender column. A comparison, however, of all the species that have been referred to the two genera discloses the peculiar fact, that some of them disagree in certain other characters which we have heretofore, in connection with other groups, and apparently with good reason, considered to be of generic value. Among these we may mention the variation in the size of the proximal or underbasal plates, in the number and arrangement of the anal pieces, and in the form and arrangement of the arm plates; but to separate them thereby, either under *Cromyocerinus* or otherwise, has so far proved utterly impossible. It is true that the underbasals in all Russian species referred to *Cromyocerinus* are exceptionally large, but only so in the adult stage. In the young specimens, as shown by Trautschold himself, they are so minute as not to extend beyond the column, so that in making the size of these plates a generic character we should be obliged to separate the young and adult.

There are, moreover, several American species which in all other respects agree with the typical forms of *Cromyocerinus*, but in which these plates, even in the adult, are exceedingly small. The same difficulty is met with in regard to the anal area. In two species—*Eupachyrcinus* Craig Meek and Worthen, and *E. Fayettensis* Worthen—the anal area is composed of a single plate, instead of three, and this even extends partly beyond the line of the radials. That this is not an abnormality, but a constant character in the species, is proved by a number of specimens. In every other group we should not hesitate to establish a new genus on this character alone; but in this case we are convinced that it is only of specific importance, since those species agree in all other respects with Meek and Worthen's typical *Eupachyrcinus*. In one specimen of another species, in our collection, only the larger, lower anal plate is absent, but this may be considered as abnormal, for the adjacent basal and radial plates show a very irregular form.

Examining the arms, we find them in two of the Russian species of *Cromyocerinus* composed of narrow, transverse, quadrangular plates; in *C. ornatus*, however, they are of cuneiform pieces which by degrees become interlocking plates. The same diversity in the structure of the arm plates is found among American species, some interlocking almost from the base of the arm, others only at the tips, while still others are constructed of a single series of

transverse plates, with parallel sutures, as in the two species of *Cromyocrinus* from Russia. We have an example in a specimen from Kentucky, which we owe to the kindness of Prof. Wetherby, evidently *Eupachyocrinus formosus* (*Zeacrinus formosus* Worth.), which in every other respect is so closely allied to *Eupachyocrinus spartarius* S. A. Miller (which has two rows of alternating arm-pieces), that the two cannot be separated unless the arms are preserved; while, on the other hand, it is almost identical with Trautschold's *Cromyocrinus geminatus*. This is sufficient to show the impracticability of subdividing *Eupachyocrinus*, and we are forced to consider *Cromyocrinus* as a synonym.

It is certainly pertinent to inquire how it is possible that the same differences in the structure of these Crinoids are in some cases of generic, and in others only of specific importance. We think the question can be answered without much speculating. In a paper, "Transition Forms in Crinoids," Proc. Acad. Nat. Sci. Phila., 1878, p. 224, we have endeavored to prove that extravagant forms are of short duration; that many genera, before they become extinct, attain extreme proportions or become extraordinarily developed in certain parts of the body. Such was the case with *Hydreionocrinus* with regard to the ventral sac, which was developed to its farthest extreme in size and proportions. In *Eupachyocrinus* the opposite extreme is reached, the same organ being reduced to almost nothing, making it almost doubtful whether the genus ought to be placed with the *Cyathocrinidae* at all; although we cannot, with our present knowledge, separate it from this family. This form was one of its very latest repre-



Encrinidæ. All this tends to explain the extraordinary modification of characters that took place within the limits of genera at the close of the Carboniferous Era.

Generic Diagnosis.—Calyx large, saucer or bowl-shaped to subglobose. Plates heavy, convex to tumid, sometimes ornamented, their arrangement unsymmetrical; sutures strongly defined.

Underbasals five, of equal size; generally small and forming a concavity; in European species comparatively larger and slightly convex. Basals large, fully as high as wide, bent upwards so that the lower half of the plates stands almost at right angles to the vertical axis, and forms a part of the basal plane, or is involved in the concavity. Three of the basals are equal, pentagonal in outline; the other two modified to accommodate the anal pieces. Radials scarcely as large as the basals, much wider than high, all pentagonal, the right posterior plate being, however, generally smaller and of a more irregular form. The upper articulating margin of the plate forms a straight line, perfectly filled by the brachials. Brachials one by five, always large, at least twice as wide as high, and frequently extended into a large spine, projecting laterally. Their outer form is almost quadrangular, although they are usually bifurcating plates. They abut laterally, closing the interradial spaces (except at the anal side) by which they appear as if a part of the calyx.

There are generally two arms to each ray or ten to the individual; sometimes only five, as in *Eupachycrinus simplex* Trautschold. They are strong, scarcely diminishing in size to the extremities, and rounded on the outside. They are variously constructed, either of a single or double series of plates, the former being either short, transverse with straight lines, or cuneiform, becoming by degrees alternately arranged and interlocking. Ambulacral groove wide and deep; Pinnules short and heavy.

Anal plates generally three, rarely one; succeeding plates forming part of the small ventral tube. The lower anal plate is largest, and sometimes attains, for a plate of this kind, unusual dimensions; it is quadrangular in outline, and rests obliquely between the posterior basal and right radial. The second plate, which is next in size and also large, is placed between the first anal and left radial, and above the basal. The third anal is much swollen, and only the lower half of it is included in the calyx. All succeeding plates, which are alternately arranged, decrease in

size upward, and form so far as known a small ventral tube, which has been traced to the height of the fourth or fifth arm plate, where it is composed of small, very delicate, hexagonal plates. The anal plates and lower portion of the tube are slightly protuberant, and give to the calyx a somewhat unsymmetrical aspect. In species with a single anal plate in the calyx, which, so far as observed, are altogether confined to the upper Coal measures, the plate is comparatively small, and rests upon the posterior basal and between the adjoining radials. There can be no doubt that this plate is the homologue of the second anal of other species, with which it closely agrees in form and position; and that the first anal plate is here absent, while the third is included in the ventral tube.

Column round and small.

The upper margin of the radials is provided with a rather prominent, narrow, articulating process, occupying the full width of the plate, corresponding to a similar process opposite on the succeeding brachial. A slit-like opening occupies the middle of it to nearly one-third of its length, which penetrates the plates and evidently contained the muscular apparatus. A similar structure is observed between the brachial and the first arm plates. Such linear processes were well adapted to facilitate the opening and closing of the arms. We may further state that in all species the lower portions of the brachials are pushed inward and the plates incline outward, owing to the position of the hinge lines which are close to the inner edge of the margin of the radial, and at the outer edge of the brachial; the outer edge of the margin of the

We recognize the following species:—

1875. *Eupachyorinus Bassetti* Worthen. Geol. Rep. Ill., vol. vi. p. 528, pl. 32, fig. 2. Coal measures. Illinois.
1870. *Eupachyor. Boydii* Meek & Worthen. Proc. Acad. Nat. Sci. Phila., p. 30. Geol. Rep. Ill., vol. v. p. 554, pl. 21, fig. 6. Chester limest. Subcarb. Chester, Ill.
1875. *Eupachyor. Craigii* Worthen. Geol. Rep. Ill., vol. vi. p. 527, pl. 32, fig. 1. Upper Coal measures. Illinois and Iowa.
Syn. Poteriocr. hemisphaericus, Shumard. 1858. Trans. St. Louis Acad. Sci., vol. i. p. 221; also *Scaphiocr. (?) hemisphaericus* Meek, 1872. Final Rep. on Nebraska, p. 147, pl. 5, fig. 1. Geol. Rep. Ill., p. 561, pl. 24, fig. 5.
- *1870. *Eupachyor. crassus* Meek & Worthen (*Cyathocr. (?) crassus*). Proc. Acad. Nat. Sci. Phila., p. 392. *Zeacr. (?) crassus*, 1866. Geol. Rep. Ill., vol. ii. pl. 26, figs. 2 a, b. Lower Coal measures. Fulton Co., Ill.
1873. *Eupachyor. Fayetteensis* Worthen. Geol. Rep. Ill., vol. v. p. 565, pl. 24, fig. 10. Upper Coal measures. Illinois.
- *1873. *Eupachyor. formosus* Worthen (*Zeacr. formosus*). Geol. Rep. Ill., vol. v. p. 549, pl. 21, fig. 2. Chester limest. Subcarb. Chester, Ill.
- *1867. *Eupachyor. geminatus* Trautschold (*Cromyocr. geminatus*). Crin. jüng. Bergkalkes, p. 25, pl. 4, fig. 6 (not 7 and 8); 1879, Kalkbrüche von Mjatschkowa, p. 120, pl. 14, figs. 5, 6. Upper Subcarboniferous. Near Moscow, Russia.
- *1858. *Eupachyor. globularis* De Koninck (*Hydeionocr. (?) globularis*). Bull. Acad. Royale Belg., pt. ii. p. 21, pl. 2, figs. 1-4. Carboniferous. Near Glasgow, Scotland.
- *1861. (?) *Eupachyor. orbicularis* Hall (*Scaphiocr. orbicularis*). Bost. Journ. Nat. Hist., p. 311. Keokuk limest. Subcarb. Keokuk, Iowa.
- *1879. *Eupachyor. ornatus* Trautschold (*Cromyocr. ornatus*). Kalkbrüche von Mjatschkowa, p. 121, pl. 14, figs. 9, 10. Upper Subcarb. Near Moscow, Russia.

Figured in "Crin. jüng. Bergkalk., pl. 4, figs. 7 and 8," under *C. geminatus*.

1876. (?) *Eupachyor. platybasalis* White. Geol. Units Mount., p. 108. Lower Aubrey Gr. Utah.

This species is imperfectly known, and very likely belongs to *Hydreionocrinus*.

1857. *Eupachyor. quatuor decimbrachialis* Lyon. Type of this genus. (*Graphiocr. quatuor decimbrachialis*) Geol. Rep. Kentucky, vol. iii. p. 477, pl. 1, figs. 2 a, b. Coal measures. Crittenden Co., Kentucky.
Syn. Cyathocrinus (?) pentalobus, Hall, 1858. Geol. Rep. Iowa, vol. i. pt. ii. p. 687, pl. 25, figs. 5 a, b.
- *1861. *Eupachyor. Sangamonensis* Meek & Worthen. (*Cyathocr. (?) Sangamonensis*) Proc. Acad. Nat. Sci. Phila., p. 392. Geol. Rep. Ill., vol. ii. p. 310, pl. 26, fig. 1 a, b. Upper Coal measures. Sangamon Co., Ill.

This species agrees very well with *Eup. globularis*, and with Trautschold's Russian species in the higher and more globose form

of the calyx, as in the large size of the underbasals, which are the only characters upon which a separation under *Cromyocrinus* might be based; but in that case what shall be done with *Eup. crassus*, which has the same form and very small underbasals?

- *1867. *Eupachyer. simplex* Trautschold. (*Cromyocr. simplex*) Crin. jüng. Bergkalk, p. 19, pl. 3, figs. 1-4; also 1879. Kalkbrüche von Mjatschkowa, p. 117, pl. 14, figs. 6-8. *Cupressocr. unciniformis* Goldfuss. Oryctographia b. Fisher, p. 151, pl. 41, figs. 5, 6; Fisher, *Poteriocr. unciniformis* Lothar von Rosalia I., p. 588; also Quenstadt. Petrol. Deutschland, iv. p. 343, pl. 109, fig. 6. Upper Subcarb. Near Moscow, Russia.

The small specimens which Trautschold has figured, and considered to be the young of *Cromyocr. simplex*, represent a very distinct species. In a specimen which we recently obtained from Prof. Zittel, the brachials in two rays are preserved, and show plainly that they are bifurcating plates, while *Cr. simplex* has but five arms. The specimen was labelled *Zeacrinus new sp.* We agree with Prof. Zittel that the calyx resembles that genus closely, but we doubt if it has more than ten arms. The length of the brachials and their form point rather to *Poteriocrinus* (*Scytalocrinus*), from which it differs in the shortness of the calyx. It evidently must be arranged with *Pot. (Scytalocrinus)? manifestis*, or as a transition form of *Eupachyocrinus*.

- *1867. *Eupachyer. subtumidus* Worthen. (*Zeocr. subtumidus*). Geol. Rep. Ill., vol. v. p. 548, pl. 21, fig. 1. Chester limest. Subcarb. Pope Co., Ill.
 1865. *Eupachyer. tuberculatus* Meek & Worthen. (*Erisocr. tuberculatus*) Proc. Acad. Nat. Sci. Phila., p. 150. Geol. Rep. Ill., vol. ii. p. 319. Upper Coal measures. Illinois and Iowa.
 *1867. *Eupachyer. verrucosus* White. (*Hydrelonocr. (?) verrucosus*). Trans.

This has been already seen as to *Poteriocrinus* and *Eupachyocrinus*, and will be still further proved in *Stemmatocrinus*, which we consider to be the Russian representative of the American genus *Erisocrinus*, although we are obliged to separate them subgenerically. Trautschold describes his genus *Stemmatocrinus* with a single subbasal plate, while in *Erisocrinus* the pelvis is distinctly divided into five pieces. We also observe a difference in the construction of the arms, which in the former are composed of a double series of interlocking plates, while in the two species of *Erisocrinus*, in which the arms have been found, they are composed of single transverse plates. Both species, however, are from the Burlington limestone, and are very small, and it is extremely probable, from analogy with contemporaries, that the arms in the species from the Coal measures, where the genus flourished more abundantly, were, as in *Stemmatocrinus*, composed of interlocking pieces, and that the Burlington species represent the young form. This would make the difference in the underbasals the only visible distinction.

Meek & Worthen, after publishing the description of *Erisocrinus*, were led by its similarity to a genus described by De Koninck under the name *Philocrinus*, from the Subcarboniferous rocks of India, to believe it identical therewith, and ranged their species under it accordingly. Later comparisons, however, led them to reconsider this. They assert that if *Philocrinus* has no subradial plates, then the two genera are clearly distinct; but, if small plates should be discovered within the plates now called basals, they are probably identical. We have never seen specimens, nor even De Koninck's description of *Philocrinus*, and are unable to express any opinion in the matter.

Generic Diagnosis.—Calyx saucer- to cup-shaped; symmetry strictly equilateral. General aspect similar to that of the two preceding genera.

Underbasals very small, forming a pentagonal, flattened, or concave disc or low cup. Basals large, uniformly hexagonal. Radials considerably larger than the basals, pentagonal, much wider than high, upper sides straight. There being no anals, the plates of each order or of each successive ring are of equal size and like form, and alternate regularly with those of successive rows. Brachials one by five, similar in form to the radials, but the lower margins are straight and the upper obtusely angular for the sup-

port of the arms. The brachials abut laterally, leaving no space for interrachial or anal plates; the hinge line constructed as in *Eupachycrinus*.

Arms two to each ray, strong, and, so far as yet observed, composed of a single series of transversely oblong pieces.

Column round or obscurely pentagonal.

Geological position, etc.—The typical form of this genus has been found only in America, where it is restricted to the Burlington limestone and Coal measures. The two Burlington species are among the rarest Crinoids of that locality, and in the Coal measures perfect calyces are rare, though fragmentary pieces have been found in some localities in great abundance.

The following species are known:—

1869. *Erisocrinus antiquus* Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 71; Geol. Rep. Ill., vol. v. p. 447, pl. 2, fig. 3. Lower Burlington limestone. Subcarb. Burlington, Iowa.
1865. *Erisocr. conoides* Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 150. Geol. Rep. Ill., vol. ii. p. 318. Upper Coal Measures. Springfield, Ill.
1865. *Erisocr. typus* Meek and Worthen. Type of the genus. Am. Jour. Sci., 2d ser. vol. xxix p. 174; Geol. Rep. Ill., vol. ii. p. 319; *ibid.* vol. v. pl. 24, fig. 6. Upper Coal Measures. Springfield, Ill.
- Syn. Philocrinus pelvis* M. and W. Am. Jour. Sci., 1866, p. 350.
- Syn. Erisocrinus Nebrascensis* M. and W. Am. Jour. Sci. 1865, p. 174.
1869. *Erisocr. Whitei* Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 72. Geol. Rep. Ill., vol. v. p. 448, pl. 2, fig. 2. Upper Burlington limestone. Burlington, Iowa.

B. Subgenus **STEMMATOCRINUS** Trautschold.

1867. Crin. d. jüngeren Bergkalkes b. Moskau, p. 28.

It is succeeded by two rows of regular interlocking plates. The arms are very heavy, rounded on the outside, continuing of the same size to near the top, where they taper to a sharp point. The articulation between the radial and brachial plates is on the same principle as in *Eupachyrinus*. There is a narrow single line across the entire width of the plate, and the outer edges of both plates adjoining it are so strongly bevelled in the typical species, that if the arms were open, nearly one-half of the brachials would rest upon, and be supported by the sloping face of the radials. Column round.

The total absence of anal plates in this and the preceding section of the genus, distinguishes it readily from any other of this family, but at the same time raises a reasonable doubt whether *Erisocrinus* and *Stemmatocrinus* possessed a solid ventral appendage, and, therefore, whether they belong to the Cyathocrinidae, or even to the Palaeocrinoidea. We have, so far, no knowledge whatever of the construction of the actinal or oral side of the body; whether it had an open mouth or was firmly closed by plates or scaly integument; and if it had not been for their marked resemblance to *Eupachyrinus* in which a ventral tube has been observed, and that both were representatives of the same geological age, living under the very same conditions, we should have felt strongly disposed to place the whole genus with *Eucrinus*, with which it has, indeed, both in body and arms, the closest affinities. That *Erisocrinus* and *Stemmatocrinus* have only one brachial, and *Eucrinus* two, is not material, and is, at the most, only of generic importance; but in *Eucrinus* the aboral side of the body, or the plates which in all Cyathocrinidae constitute the calyx, form almost a flat disc—at least do not extend beyond the basal plane—and this is the only important distinction which can be discovered between the two forms in the fossil state. This, however, may involve important structural modification in the internal anatomy of the animal, and probably shut out *Eucrinus* entirely from the Palaeocrinoidea.

Geological Position, etc.—*Stemmatocrinus* is only known from the limestone beds of Mjatschkowa, where Prof Trautschold discovered the only species.

1867 *Stemmatocrinus cornuus* Trautsch. Bulletin d. l. Soc. d. Nat. de Moscou, 1867, also Monogr. d. Kalkbr. v. Mjatschkowa, 1872, p. 125, pl. 11, fig. 12. Upper part of Subcarbon., near Moscow, Russia.

21. (1) *EUSPIROCRINUS* Angelin.

1878. Iconogr. Crinoid., Suec. p. 24.

General form, including arms, short subcylindrical. Calyx cyathiform, unsymmetrical.

Underbasals five, subequal. Basals five, four of them with acute upper angles; the fifth heptagonal, the upper angle being truncate to meet the second anal, its left upper side resting against the adjoining first radial, the oblique right side against the first anal plate. Radials large, sublunular. Brachials two, wide, very short.

Arms dichotomizing, and on becoming free coiled up spirally inward.

Anal area wide, plates large, alternately arranged as in *Poteriocrinus*. Ventral tube rather slender, and composed of but few exceedingly large plates.

Vault constructed of five large oral plates; the ambulacral furrows, which divide within the disc for the two main divisions of each ray, covered by alternating pieces; the median part of the dome closed by rather large apical dome plates.

Column short, composed of alternately larger and smaller joints; central canal moderately large.

We place the genus *Euspirocrinus* by itself, as it differs from all other Cyathocrinidæ in its peculiar arm structure, in which it somewhat resembles *Edriocrinus* Hall, and the recent genus *Holopus* D'Orb. It also differs in the construction of the ventral sac, which appears like the proboscis of the Actinocrinidæ, except that



Carabocrinus, in our opinion, is founded upon a malformed or recuperated *Cyathocrinus*. A comparison of the two genera will show that on the anterior side they are perfectly identical; they also agree most remarkably in the form of the calyx, the construction of the oral side, the delicacy of the arms, and their mode of branching. The only difference is said to be in the construction of the anal area, which, according to Billings, is composed of three plates, the lower one resting upon the underbasals, which is in itself an anomaly such as is found in no other genus. But, further, if Billings's interpretation of the plates in question be correct, the anal area in *Carabocrinus* would be directed toward the left side of the specimen, which would be the only exception among the Palæocrinoidea, and there exists in no other group of them a basal (subradial of Billings) which is neither radial nor interradiar, and which is disconnected from the radials, as would be the case in this genus. (See Billings's Diagram, Dec. iv. p. 30, and pl. 2, fig. 3 c.) In this specimen, which is the only example in which the anal area has been observed, the small and abnormal so-called subradial and the two anal plates of Billings combined, have almost the form of one of the other basals (subradials) and are but slightly larger, and we think that in the specimen they originally formed a single plate, which was accidentally broken during the life of the animal and afterwards recuperated, leaving marks of fracture which Billings took to be sutures between the plates. Similar cases are frequently met with among fossil crinoids, plates being sometimes broken into a dozen or more pieces, which afterwards reunite, each piece retaining the appearance of a true plate.

Geological position, etc.—Billings recognizes the following species:—

1856. *Carabocrinus radiatus* Billings. Type of the genus, and the only species and specimen in which the anal area has been seen. Geol. Surv. Canada, p. 276; Decade iv. p. 31, pl. 2, fig. 3 a-c. Trenton Limestone, Lower Sil. Ottawa, Canada.

1859. *Carabocr. (?) tuberculatus* Billings. Geol. Surv. Can., Dec. iv. p. 33, pl. 10, figs. 2 a-c. Hudson River Gr. Lower Sil. Anticosti.

1859. *Carabocr. van cortlandti* Billings. Geol. Surv. Can., Dec. iv. p. 32, pl. 2, fig. 4. Trenton Limestone, Lower Sil. Township of McNab, Canada.

23. (?) *CYRTIDOCRINUS* Angelin.

1878. Iconogr. Crin. Suec., p. 20.

This genus is not only very imperfectly known—a single calyx only having been thus far discovered—but it also deviates so materially from all other Cyathocrinidæ, that we doubt whether it can be properly classed with that family. According to Angelin it has four underbasals, which are small and unequal in size. Basals five, pentagonal or hexagonal. A single anal plate is intercalated between two basals and two radials. Radials five-sided, oblique, clypeiform.

1878. *Cyrtidocrinus fasciatus* Angelin. Iconogr. Crin. Suec., p. 20, pl. 31, figs. 13, 14, 14 a. Upper Silur. Gotland, Sweden.

24. (?) *PACHYOCRINUS* Billings.

1859. Geol. Surv. Canada, Dec. iv. p. 22. (Not *Pachyocrinus* Eichwald.)

In the single specimen to which Billings applied the above name, there are five pentagonal plates concealed within the cavity for the attachment of the column, and above and alternating with them five very large, thick plates, which may be either basals or radials. The lower portions of these plates are bent under the body, so as to constitute a broad, rounded, or concave bottom to the cup, which has a width of nine lines at a height of two. At this level the cup is broken off in the specimen.

Billings refers to this genus:—

1859. *Pachyocrinus crassibrachialis* Billings. Geol. Surv. Can., Dec. iv. p. 22, pl. 1, figs. 1 a, b. Chazy Limest. Montreal, Canada.



three; parabasals five, polygonal. Primary radials one, forming a single zone; secondary radials in two series, the upper ones triangular and arm bearing. Interradials (probably anals) two. Arms long, threadlike, dichotomizing several times, composed of single joints. Ventral tube distinct, articulated. Column strong, convoluted, composed of thin joints with numerous articulated cirrhi." He places this genus under his division "Trimera" (along with *Taxocrinus* and *Gissocrinus*), among the Taxocrinidæ.

Comparing Angelin's figures, we find that only his *M. heterocrinus* agrees with the description. His *M. gracilis* has five primary radials, or, as we should say, four brachials; his *M. (?) interrimalis* three to four, and, contrary to the rule in all Cyathocrinidæ, a number of interrimal plates. None of the species, however, exhibit the peculiar arm structure upon which Hall founded the genus; but, on the contrary, the two first-named species at least seem to be devoid of pinnulæ. Angelin figures—pl. 10, fig. 25—an isolated convoluted column with numerous cirrhi, which is said to belong to *M. gracilis*, and it seems that the superficial resemblance of this column to the so-called arms of *Myelodactylus* induced Angelin to adopt Hall's name for his species. We cannot see any propriety in founding genera or species upon mere fragments of arms or column, especially in a case like this, where we are by no means satisfied that Hall's figure represents the column, but rather believe, with him, that they are most probably portions of arms. We have here placed *Myelodactylus* provisionally under the Cyathocrinidæ, because Angelin's first two species undoubtedly belong to that family, though probably to different genera. His *M. (?) interrimalis*, however, is a representative of an altogether different family. They all differ from the Ichthyocrinidæ in the large underbasals, in the free plates above the first radials, the threadlike arms, and the general physiognomy. So far as we know, the species agree with no established genus, but the figures without descriptions are not sufficient for us to found new genera upon.

Hall places here the following species:—

1851. *Myelodactylus brachiatus* Hall. Geol. Surv. N. Y., Pal., vol. ii. p. 232, pl. 45, fig. 7. Niagara Gr. Upper Sil. Near Lockport, N. Y.

1851. *Myelodactylus convolutus* . Geol. Surv., N. Y., Pal., vol. ii. p. 191, pl. 42, figs. 5 a, b, and 6 a-h. Niagara Gr. Upper Sil. Lockport, N. Y.

LIST OF SYNONYMS, CORRECTIONS, AND IMP
DEFINED SPECIES.

Aetinoecrinus Miller.

A. arthriticus, Phill., see *Gissoecr. arthriticus*.

Adoleocrinus Phillips, founded upon fragments of column.

A. hystrix Phill., founded upon fragments of column.

Ataxocrinus Lyon, syn. of *Anomalocr.* M. & W.

Bactocrinites fusiformis Schnur., see *Homocrin. fusiformis*.

Batrocrinus Volborth, syn. of *Hybocrinus* (Zittel).

Baryocrinus Wachsmuth.

B. Lyoni (Hall's sp.), see *Vasocr. Lyoni*.

Cladocrinus Austin (not Agassiz), see *Taxocrinus*.

C. brevidactylus Aust. see *Taxocr. brevidactylus*.

C. pentagonus Aust., see *Poteroecr. pentagonus*.

Cladocrinus Billings

C. grandis Bill., founded on fragments of column.

C. magnificus Bill., founded on fragments of column.

Clidochirus Angl., var. of *Calpiocrinus* Angl.

Cromyocrinus Trautschold, syn. of *Eupachycrinus* M. & W.

* *C. geminatus* Trautsch., see *Eupachycr. geminatus*.

C. ornatus Trautsch., see *Eupachycr. ornatus*.

C. simplex Trautsch., see *Eupachycr. simplex*.

Cupulocrinus d'Orbigny, syn. of *Taxocrinus*.

Capressocrinus, Goldf.

C. nuciformis Goldf., see *Eupachycr. simplex*.

Genthoecrinus Miller

- C. cornutus* O. & Shum., see *Baryer. cornutus*.
C. corrugatus (?) Troost. Catalogue name.
C. crassibrachiatus Hall, see *Baryer. crassibrachiatus*.
C. crassus M. & W., see *Eupichyer. crassus*.
C. crateriformis? Catalogue name.
C. decadactylus Lyon & C., *Pot. (Scytalocr.) grandis*.
C. decophyllus Ad. Roemer, founded on fragments of column.
C. depressus Troost. Catalogue name.
C. distans Phill., founded on fragments of column.
C. divaricatus Hall, see *Cynthocr. lawensis*.
C. dubius Munster, not distinctly defined.
C. ellipticus Phill., founded on fragments of column.
C. exilis Eichw., founded on fragments of column.
C. floralis O. & Shum., see *Zuer. floralis*.
C. foreolatus, Eichw., founded on fragments of column.
C. globosus Troost. Catalogue name.
C. Gosa Ad. Roemer, imperfect specimen.
C. gracilis Troost. Catalogue name.
C. gracilior F. Roemer, *Poteriocr. gracilior*.
C. granulatus Angl., see *Arachnocr. granulatus*.
C. granuliferus Shum. 1852. We have not seen the description.
C. hexadactylus Lyon, see *Vasocr. Lyoni*.
C. Hoveyi Hall, see *Baryer. Hoveyi*.
C. inequidactylus McCoy, see *Poteriocr. inequidactylus*.
C. inflatus Troost. Catalogue name.
C. interbrachiatus Angl., see *Cinorimoer. Lorent W. & Spr.*
C. intermedius Hall, see *Pot. (Pariocr.) intermedius*.
C. Kelloggi White, see *Baryer. Kelloggi*.
C. lariculus Lyon, see *Poteriocr. lariculus*.
C. latus Hall, see *Baryer. sculptilis*.
C. Lyoni Hall, see *Vasocr. Lyoni*.
C. macrocheirus McCoy, see *Poteriocr. macrocheirus*.
C. macrodactylus Phill., see *Taxocr. macrodactylus*.
C. macropleurus Hall, see *Vasocr. macropleurus*.
C. magister Hall, see *Baryer. magister*.
C. magnoliiformis Norw. & Ow., see *Zuer. magnoliiformis*.
C. malvaceus Hall, see *Cynthocr. lawensis*.
C. megastylus Phill. Fragments of column.
C. nodulosus Phill. Fragments of column.
C. ornatus Phill., perhaps *Platyocranus*?
C. penniger De Vern. Not seen description.
C. pentalobus Hall, see *Eupichyer. quatuordecimbachiatus*.
C. pinnatus Goldf. Cluster of arms of some other genus.
C. pinnatus Bronn. Not seen description.
C. protuberans Hall, see *Baryer. bullatus*.
C. pusillus Hall, see *Lecanocr. pusillus*.
C. pyriformis Phill., see *Ichthyocr. pyriformis*.
C. quinquangulatus Miller, see *Pot. (Pariocr.) quinquangulatus*.
C. quinquelobus M. & W., see *Baryer. stellatus*.
C. rarus Lyon. Too imperfect for identification.

- C. Rhenanus* F. Roemer, see *Taxocr. Rhenanus*.
C. robustus Troost. Catalogue name.
C. Rosmeri Troost. Catalogue name.
C. rugosus Miller (not Goldf.), is *Crotalocr. rugosus*.
C. Sangamonensis M. & W., see *Euparkyer. Sangamonensis*.
C. scutulus M. & W., see *Barycr. sculptilis*.
C. sculptilis Hall, see *Barycr. sculptilis*.
C. sculptus Troost. Catalogue name.
C. sculptus Lyon, see *Vasocr. sculptus*.
C. solidus Hall see *Barycr. solidus*.
C. spurius Hall, see *Barycr. spurius*.
C. stellatus Hall, see *Barycr. stellatus*.
C. subtumidus M. & W., see *Barycr. subtumidus*.
C. Tennesseeus Troost. Catalogue name.
C. tenuiradiatus Lyon. Insufficiently defined.
C. tetracontadactylus Salter, *Pionocr. tetracontadactylus*.
C. thomæ Hall, see *Barycr. thomæ*.
C. tricarinatus Ad. Roemer. Fragments of column.
C. tuberculatus Miller, see *Taxocr. tuberculatus*.
C. tumidus Hall, see *Barycr. tumidus*.
C. valens Lyon, see *Vasocr. valens*.
C. variabilis Phill. Fragments of column.
C. viminalis Hall, syn. of *Cynthocr. Iowensis*.
C. Wacksmuthi M. & W., see *Barycr. Wacksmuthi*.
C. Wortheni Lyon, see *Poteriocr. Wortheni*.

E isocrinus Meek & Worthen.

- E. tuberculatus* M. & W., see *Euparkyer tuberculatus*.

Euryalecrinus Austin, syn. of *Taxocrinus*.

Euryocrinus Phill., see *Ichthyocrinus*.

Forbesioocrinus De Kon. & Leb.

- F. asteriaformis* Hall, see *Onychocr. asteriaformis*.

- F. tetracantus* Angl. see *Isathocr. denticulatus*.

- C. cornutus* O. & Shum., see *Barycr. cornutus*.
C. corrugatus (?) Troost. Catalogue name.
C. crassibrachiatus Hall, see *Barycr. crassibrachiatus*.
C. crassus M. & W., see *Eupachycr. crassus*.
C. crateriformis? Catalogue name.
C. decadactylus Lyon & C., *Pot. (Scytalocr.) grandis*.
C. decophyllus Ad. Roemer, founded on fragments of column.
C. depressus Troost. Catalogue name.
C. distans Phill., founded on fragments of column.
C. divaricatus Hall, see *Cyathocr. lowensis*.
C. dubius Münster, not distinctly defined.
C. ellipticus Phill., founded on fragments of column.
C. exilis Eichw., founded on fragments of column.
C. florealis O. & Shum., see *Zeacr. florealis*.
C. foreolatus, Eichw., founded on fragments of column.
C. globosus Troost. Catalogue name.
C. Gosæ Ad. Roemer, imperfect specimen.
C. gracilis Troost. Catalogue name.
C. gracilior F. Roemer, *Poteriocr. gracilior*.
C. granulatus Angl., see *Arachnocr. granulatus*.
C. granuliferus Shum. 1852. We have not seen the description.
C. hexadactylus Lyon, see *Vasocr. Lyoni*.
C. Hoveyi Hall, see *Barycr. Hoveyi*.
C. inequidactylus McCoy, see *Poteriocr. inequidactylus*.
C. inflatus Troost. Catalogue name.
C. interbrachiatus Angl., see *Gnorimocr. Loveni* W. & Spr.
C. intermedius Hall, see *Pot. (Parisocr.) intermedius*.
C. Kelloggi White, see *Barycr. Kelloggi*.
C. laviculus Lyon, see *Poteriocr. laviculus*.
C. latus Hall, see *Barycr. sculptilis*.
C. Lyoni Hall, see *Vasocr. Lyoni*.
C. macrocheirus McCoy, see *Poteriocr. macrocheirus*.
C. macrodactylus Phill., see *Taxocr. macrodactylus*.
C. macropleurus Hall, see *Vasocr. macropleurus*.
C. magister Hall, see *Barycr. magister*.
C. magnoliaformis Norw. & Ow., see *Zeacr. magnoliaformis*.
C. malvaceus Hall, see *Cyathocr. lowensis*.
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C. ornatus Phill., perhaps *Platyserinus*?
C. penniger De Vern. Not seen description.
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C. pinnatus Goldf. Cluster of arms of some other genus.
C. pinnatus Bronn. Not seen description.
C. protuberans Hall, see *Barycr. bullatus*.
C. pusillus Hall, see *Lecanocr. pusillus*.
C. pyriformis Phill., see *Ichthyocr. pyriformis*.
C. quinquangularis Miller, see *Pot. (Parisocr.) quinquangularis*.
C. quinquelobus M. & W., see *Barycr. stellatus*.
C. rarus Lyon. Too imperfect for identification.

- P. pulchellus* Bill., see *Cyathocr. pulchellus*.
P. rhombiferus Bill., see *Cyathocr. rhombiferus*.
P. striatus Bill., see *Cyathocr. striatus*.

Phialocrinus Eichw. (not Trautsch.). Fragments of column.

- P. impressus* Eichw. Fragments of column.

Phialocrinus Trautsch. (not Eichw.), subgenus of *Graphocrinus*.

- P. urna* Trautsch., see *Poteriocr. (Scytalocr.) urna*.

Philocrinus De Kon.

- P. pelvis* M. & W., see *Erisocr. typus*, M. & W.

Poteriocrinus Miller.

- P. abbreviatus* Aust., see *Taxocr. brevidactylus*.
P. alternatus Hall, see *Dendrocr. alternatus*.
P. Barrisi Hall, see *Cyathocr. Barrisi*.
P. bursaformis White., see *Zenocr. bursaformis*.
P. caduceus Hall, see *Dendrocr. caduceus*.
P. calyx De Kon. & Leh., see *Hydromocr. calyx*.
P. carinatus M. & W., see *Poteriocr. (Pachylocr.) liliiformis*.
P. casei Meek, see *Dendrocr. casei*.
P. Cincinnatiensis Meek, see *Dendrocr. Cincinnatiensis*.
P. concinnus M. & W., see *Poteriocr. (Pachylocr.) concinnus*.
P. Coreyi Worthen, see *Poteriocr. (Scytalocr.) grandis*.
P. corycia Hall, see *Poteriocr. (Scaphiocr.) corycia*.
P. crassimanus Eichw. Fragments of column.
P. crateriformis Troost. Catalogue name.
P. cultidactylus Hall, see *Poteriocr. (Scaphiocr.) cultidactylus*.
P. cylindricus Hall, see *Homoer. cylindricus*.
P. dilatatus Hall (not Schultze), see *Calocr. dilatatus*.
P. dilatatus Schultze (not Hall), see *Vasocr. dilatatus*.
P. Dudleyensis Aust., see *Cyathocr. Dudleyensis*.
P. Dyeri Meek, see *Dendrocr. Dyeri*.
P. latissimus Paddy, see *Latissimus* De Kon.

- P. McCoyanus* De Kon. & Leh., see *Hydreionocr. McCoyanus*(?)
P. mespiliformis Richt. & Ung. Not sufficiently known.
P. Meekianus Shum., see *Cyathocr. Meekianus*.
P. multiplex Trautsch., see *Poteriocr. (Scaphiocr.) multiplex*.
P. municipalis Troost. Catalogue name.
P. nanus Roemer, see *Homocr. nanus*
P. nuciformis Fischer (Goldf.), see *Eupachyer. simplex*.
P. occidentalis O. & Shum., see *Agassizocr. occidentalis*.
P. parvus Hall, see *Homocr. parvus*.
P. Phillipsianus De Kon. & Leh., see *Hydreionocr. Phillipsianus*.
P. pisiformis Roemer, see *Arachnocr. pisiformis*.
P. posticus Hall, see *Dendrocr. posticus*.
P. proboscidiæ Worthen, see *Poteriocr. (Scaphiocr.) proboscidiæ*.
P. Rhenanus Wirtg. & Zeiler, see *Taxocr. Rhenanus*.
P. rhombiferus O. & Shum., see *Barycr. rhombiferus*.
P. solidus M. & W., syn. of *Poteriocr. (Scaphiocr.) æqualis*.
P. spinosus O. & Shum., see *Poteriocr. (Scaph.) spinosus*.
P. subgracilis D'Orb., see *Dendrocr. gracilis*.
P. subimpressus M. & W., see *Poteriocr. (Scaphiocr.) subimpressus*.
P. Swallovi M. & W., see *Poteriocr. (Scaphiocr.) swallovi*.
P. tenuidactylus M. & W., syn. of *Poteriocr. (Scaphiocr.) tenuidactylus*.
P. tenuissimus Eichw. Fragments of column.
P. tumidus O. & Shum., see *Agassizocr. tumidus*.
P. varians Eichw. Fragments of column.
P. ventricosus Hall, see *Caliochr. ventricosus*.
P. zeæformis Schultze. Not defined.

Scaphiocrinus Hall. A variety of *Poteriocrinus*.

- S. abnormis* Worthen, see *Poteriocr. (Scytalocr.) abnormis*.
S. ægina Hall, see *Poteriocr. (Decadocr.) ægina*.
S. æqualis Hall, 1861 (not 1859), see *Poteriocr. (Pachylocr.) subæqualis*.
S. Bayensis M. & W., see *Poteriocr. (Decadocr.) Bayensis*.
S. carinatus M. & W. (not Hall), see *Poteriocr. (Pachylocr.) liliiformis*.
S. carbonarius M. & W., see *Graphiocr. carbonarius*.
S. decadactylus Worthen, see *Poteriocr. (Scytalocr.) grandis* W. & Spr.
S. depressus M. & W., see *Poteriocr. (Decadocr.) depressus*.
S. fuscillus M. & W., see *Poteriocr. (Decadocr.) fuscillus*.
S. Halli Hall, see *Poteriocr. (Decadocr.) Halli*.
S. hemisphericus Shum. (Meek), see *Eupachyer. Craigii*.
S. juvenis M. & W., see *Poteriocr. (Decadocr.) juvenis*.
S. longidactylus McChesn., see *Poteriocr. (Scytalocr.) decabrachiatus*.
S. lyriope Hall, see *Poteriocr. (Decadocr.) lyriope*.
S. macrodactylus M. & W., see *Poteriocr. (Scytalocr.) macrodactylus*.
S. macropleurus Hall, see *Vasocr. macropleurus*.
S. McAdamsi Worthen, see *Graphiocr. McAdamsi*.
S. notabilis M. & W., see *Poteriocr. notabilis*.
S. orbicularis Hall, *Eupachyer. orbicularis*.
S. rudis M. & W., see *Graphiocr. rudis*.
S. scalaris M. & W., see *Poteriocr. (Decadocr.) scalaris*.
S. simplex Hall, see *Graphiocr. simplex*.

- S. spinobrachiatus* Hall, see *Graphioer. spinobrachiatus*.
S. striatus M. & W., see *Graphioer. striatus*.
S. sub tortuosus Hall, see *Poteroer. (Decadoer.) sub tortuosus*.
S. tortuosus Hall, *Graphioer. tortuosus*.
S. Wachsmuthi M. & W., see *Graphioer. Wachsmuthi*.
S. Whitai Hall, see *Poteroer. Whitai*.

Sphærocrinus Roemer. A variety of *Cyathocrinus*.

Taxocrinus Phillips.

- T. Austini* Angl., see *Gnorimocr. Austini*.
T. briareus Schultz, see *Cynthocr. briareus*.
T. distensus Angl., see *Gnorimocr. distensus*.
T. excavatus Angl., see *Gnorimocr. excavatus*.
T. expansus Angl., see *Gnorimocr. expansus*.
T. interbrachiatus Angl., see *Gnorimocr. interbrachiatus*.
T. oblongus Angl., see *Gnorimocr. oblongus*.
T. oralis Angl., see *Gnorimocr. oralis*.
T. punctatus Angl., see *Gnorimocr. punctatus*.
T. polydactylus McCoy, see *Onychocr. polydactylus*.
T. rigens Angl., see *Gnorimocr. rigens*.
T. Salteri Angl., see *Gnorimocr. Salteri*.
T. simplex Salter, see *Pionocr. simplex*.
T. tesseracontadactylus d'Orb., see *Pionocr. tesseracontadactylus*.
T. tubuliferus Angl., see *Gnorimocr. tubuliferus*.

Zenocrinus Troost.

- Z. arboreus* Worthen, see *Poteroer. (Pachyloer.) arboreus*.
Z. armiger M. & W., see *Hydreionocr. armiger*.
Z. asper M. & W., see *Poteroer. (Pachyloer.) asper*.
Z. concinnus M. & W., see *Poteroer. (Pachyloer.) concinnus*.
Z. depressus Troost., see *Hydreionocr. depressus*.
Z. discus M. & W., see *Hydreionocr. discus*.
Z. excavatus Schultz, see *Gnorimocr. excavatus*.
Z. f. novus Worthen, see *E. f. novus* f. novus.

EXPLANATION OF PLATE 15.

Letters referring to all figures on this plate: *u* = underbasals; *b* = basals; *r* = radials; *r*¹ = primary radials; *r*² = secondary radials; *r*³ = tertiary radials; *p* = patelloid plates; *a* = arm plates; *i* = interradians; *d* = axillary plates; *an* = anal plates; *br* = brachial plates; *A* = anterior side; *P* = posterior side.

Fig. 1. Diagram of *Forbesiocrinus*, showing the fundamental arrangement of plates in the Ichthyocrinidæ.

Fig. 2. Diagram of *Taxocrinus*, showing, in connection with Fig. 1, the distinction in the anal side between this genus and *Forbesiocrinus*.

Fig. 3. Diagram of *Baryocrinus*, showing the fundamental arrangement of plates in the Cyathocrinidæ.

Fig. 4. Apical plates in *Actinocrinus*.

Fig. 5. Apical plates in *Platycrinus*.

EXPLANATION OF PLATE 16.

Fig. 1. Diagram of *Anomalocrinus*.

Fig. 2. Diagram of *Heterocrinus*.

Fig. 3. Diagram of *Iocrinus*.

This and the following figures on this plate are given to show the development of the anal plates from one genus to another.

Fig. 4. Diagram of *Hybocrinus*.

Fig. 5. Diagram of *Dendrocrinus*.

Fig. 6. Diagram of *Homocrinus*.

Fig. 7. Diagram of *Poteriocrinus*.

Fig. 8. Diagram of *Cyathocrinus*.

EXPLANATION OF PLATE 17.

Fig. 1. Pentacrinoid larva of *Antedon rosacea*. (After Allman.) *s* = stem; *cd* = centrodorsal plate; *b* = basals; *r* = radials; *or* = oral plates.

Fig. 2. Ventral side of *Cyathocrinus*, showing the oral plates, the apical and radial dome plates being removed.

d
or = oral plates—equivalent to *d* in Fig. 4.

Fig. 3. Ventral side of *Cupressocrinus*, showing the hydrospires; *h* = consolidating apparatus of European authors; *g* = openings which, from

their relative position, we suppose may be equivalents of the passage in the inner lancet pieces in *Pentremites*, designated as *l* in Fig. 5.

Fig. 4. Summit of *Pentremites*, showing the deltoid pieces and their appendages—hidden from view by the test in perfect specimens; *a* = anal opening; *h* = hydrospires; *o* = inner wall or floor of the passage (so-called ovarian openings) leading to the hydrospires; the outer wall, which is a part of the pseudambulacrum, having been removed from the specimen; *d* = the outer or visible portion of the deltoid pieces—equivalent to *d* in Fig. 3; *l* = plates lying directly below the lancet pieces, with tubular passage running lengthwise through them (see *l* in Fig. 5); *b* = passage formed by the edges of two deltoid pieces and the inner lancet piece, externally covered by the pseudambulacrum—equivalent to the opening at the base of the arms in Paleocrinoidea.

This figure is a representative of the structure of this portion of the Blastoid, as ascertained by examination of a number of specimens, some in which parts of the test have been removed, others in form of polished sections. It is based upon observation, not imagination, and this figure, in connection with No. 5, will, we hope, enable the reader to understand a construction always difficult to explain, and which is now, for the first time, correctly figured, as we believe. We have not attempted to illustrate the details upon which our figure is based, because our object at present is only to point out certain affinities between some forms of Paleocrinoidea and the Blastoidea.

Fig. 5. Cross section of *Pentremites pyriformis* Say (at one-half the height of the ambulacrum, one ray of the latter being removed).

f = the halves of the forked plate; *L* = lancet pieces; *l* = inner lancet pieces; *p* = pore pieces; *m* = ambulacral groove and food passage—covered in perfect specimens; *c* = pores on the ambulacral field.

Figs. 6, 7, 8. Hydrospires of *Caryocrinus ornatus*. 6. Surface view, showing the openings through the test. 7. Representing the course of the



NOVEMBER 11.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-two persons present.

The death of J. Aitken Meigs, M.D., a member, was announced.

The following papers were presented for publication:—

“Reply to Dr. M. C. Cook’s criticism of paper on Variability of *Sphæria Quercuum*, Sz.” By J. B. Ellis.

• “On a collection of Crustacea from Virginia, North Carolina, and Florida, with a revision of the genera of Crangonidæ and Palæmonidæ.” By J. S. Kingsley.

• *Correction to paper on Hyraceum.*—Dr. A. J. Parker called attention to the fact that in the paper entitled “Note on Hyraceum,” Proc. A. N. S. Philad. 1879, p. 12, sulphydric acid should be substituted for sulphuric acid in fifth line from the bottom of the page.

NOVEMBER 18.

Mr. MEEHAN, Vice-President, in the chair.

Twenty-three persons present.

A paper entitled “On the Stratigraphical Evidence afforded by the Tertiary Fossils of the Peninsula of Maryland.” By Angelo Heilprin, was presented for publication.

On the Genus Garberia.—At the meeting of the Botanical Section, held on 10th inst., Mr. Redfield presented the following communication from Dr. ASA GRAY:—

“I wish to secure an opportunity which occurs to dedicate a genus of plants peculiar to Florida to Dr. A. P. Garber, of Pennsylvania, who has done such good botanical service in his recent faithful exploration of the southern portion of Florida. Among the rest, he has rediscovered the interesting plant which will now commemorate his name and services. This plant is the *Liatris fruticosa*, of Nuttall, before collected only by Mr. Ware in scanty specimens. In the Transactions of the American Philosophical Society (N. Ser., vii. 285), Nuttall formed for it a subgenus, *Leptoclinium*. In the Proceedings of the American Academy of Arts and Sciences, xv. 48, issued only a month ago, I raised this to generic rank, in view of characters which need not here be reca-

pitulated. But I carelessly overlooked the patent fact that the late George Gardner had published, in 1846, a *Liatris* (*Leptoclinium*) *Brasiliensis*, which he supposed to be a relative of Nuttall's *Liatris* (*Leptoclinium*) *fruticosa*, and that Bentham, in the *Genera Plantarum*, in view of the pentangular achenium of the Brazilian plant and other characters, founded a genus upon it, and unhappily gave it the name of *Leptoclinium*. All this I unaccountably overlooked. Now, although the name *Leptoclinium* ought properly to belong to the North American plant, a subgeneric name has no rights as against a published generic name. So a new name must be provided for the Florida plant. I had thought at the first of dedicating it to Dr. Garber, but I deferred to the subgeneric name given already by Nuttall; and I now do with alacrity what I ought to have done in the first place. The name and synonymy will stand thus:—

GARBERIA FRUTICOSA. *Liatris fruticosa*, Nutt., in Am. Journ. Sci. v. 299, and Trans. Am. Phil. Soc. 1. c. (subgen. *Leptoclinium*). *Leptoclinium fruticosum*, Gray, Proc. Am. Acad. xv. 48, S. Florida, Ware, Garber."

NOVEMBER 25.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-eight persons present.

A paper entitled "Carcinological Notes, No. I.," by J. S. Kingsley, was presented for publication.

Authority was granted the Mineralogical Section to change the name to the "Mineralogical and Geological Section of the Academy of Natural Sciences of Philadelphia."

The following were elected members: Benjamin Sharp, H. Rus-

REPLY TO DR. M. C. COOKE'S CRITICISM OF PAPER ON "VARIABILITY
OF SPHÆRIA QUERCUM, SZ."

BY. J. B. ELLIS.

In the last number of *Grevillia* the editor of that Journal makes some statements with regard to my paper on *Sphæria Quercum*, published in the Proceedings of the Academy of Natural Sciences of Philadelphia last March, which need correction. He says "It matters not that the sporidia vary in size and form, that in some (of the species) they should be obtuse, in others rather acute at the extremities, in some hyaline, in others deep brown." Dr. Cooke, who has examined the specimens, must have known that these various forms of sporidia instead of being characteristic of different species are all to be found in the same perithecium, the narrow and acute forms being in fact only young or imperfect. As to the sporidia being "hyaline in some and in others deep brown," the record in *Grevillea* contradicts that statement, so far at least as the species of C. and E. are concerned, *Melogramma Aceris* alone excepted; and even in this species my specimens have the sporidia hyaline. *S. eriostiga* is also said to have the sporidia brown and biseptate; but it is added that these were free spores, the sporidia actually observed in the asci being hyaline. In my previous paper I stated, and subsequent observation has confirmed the statement, that brown biseptate spores are found in *all* the different forms but as yet not in asci. They occur but sparingly it is true, but a careful and patient search is sure to reveal their presence. I wish here to amend my original statement so far as the color of the sporidia is concerned. In all fresh specimens examined, the sporidia are hyaline. Some specimens on *Quercus alba* and on *Vaccinium Pennsylvanicum*, both of which had been poisoned, have brown sporidia, but as the color may be due to the action of the poison, it will be safer to assume that the sporidia are hyaline till the examination of fresh and living specimens shall show them to be brown.

It is asked why twenty other species having similar sporidia were excluded from the list? Simply because I had not actually examined specimens of these species, and it was not intended to give mere opinion, but to state facts actually observed. As to

"ignoring all variations of internal structure" and "discarding all external features," I am willing to let the specimens speak for themselves.¹

¹ I intended to add to the original paper a foot note, designating all the forms with perithecia not united in a stroma as *var. simplex*, but as no additions could be made after the article was in type, I was obliged to content myself with adding this note with pen and ink to the copies sent me for distribution.

**ON A COLLECTION OF CRUSTACEA FROM VIRGINIA, NORTH CAROLINA,
AND FLORIDA, WITH A REVISION OF THE GENERA OF CRANGONIDÆ
AND PALEMONIDÆ.**

BY J. S. KINGSLEY.

The specimens enumerated below were collected, with a few exceptions, by Prof. H. E. Webster, of Union College, at Northampton County, Virginia (eastern shore, Atlantic side), beach of Chesapeake Bay, opposite Fort Monroe, Va., in the vicinity of Beaufort, N. C., and Marcou Pass, Florida Bay, Harbor Key, Plantation Key, and Key West, Southern Florida, and Oyster Bay, Charlotte Harbor, Sarasota Bay and Little Sarasota Bay, on the west coast of Florida. I have endeavored to indicate to a certain extent the geographical distribution of the species by giving, in most instances, a list of localities from which specimens have been reported, with the authority for the statement. In cases where I have personally examined specimens, I have placed an exclamation mark (!) after the locality followed by the name of the collector. The arrangement followed in the Maioidæ is that of Miers (Jour. Linn. Soc'y, xiv. pp. 634-673, 1879). In the remaining groups of the Brachyura, mainly that of Dana, the Anomura, according to Stimpson (Proc. Acad. Nat. Sci. Philadelphia, 1858, pp. 225-238), while the order of the Macrura is essentially that of Dana. A short notice of some of the new forms will be found in the American Naturalist, vol. xiii. p. 584, September, 1879.

ORDER DECAPODA.

Sub-Order MAIOIDEA *vel* OXYRHYNCHA.

FAMILY INACHIDÆ Miers.

Sub-Family Leptopodinae Miers.

Genus LEPTOPODIA Leach.

***Leptopodia sagittaria* Leach.**

Cancer sagittarius Fabr., Ent. Syst., ii. p. 442.

Inachus sagittarius Fabr., Suppl. Ent. Syst., p. 359.

Macropus sagittarius Latreille, Hist. Crust. et Insects, ii. p. 112.

Leptopodia sagittaria Leach, Zool. Misc., ii. pl. lxvii.

Leptopodia ornata Guldin, Trans. Linn. Soc'y London, xiv. p. 335 (1823).

Leptopodia lanceolata Brullé in Webb and Berthelot's Hist. Canaries, pl. i. (1836-1844).

Five specimens were collected at Sarasota Bay, Fla. This species has quite an extended range in the tropics. Stimpson reports it from the Florida Reefs and Madeira Is.; von Martens from Cuba; Guadeloupe (Latr., Martens, and Desbonne), Gulf of Mexico and Antilles (Edw. and Gibbs), Canary Is. (Brullé), Cayenne and Bahia, Brazil (A. M. Edw.). Alphonse Milne Edwards maintains the identity of *Leptopodia debilis* Smith¹ with this species. If it prove identical, the following localities on the west coast of America will have to be added to the list: Valparaiso (Bell, Edw., and Lucas), Panama (Smith), Realijo, west coast of Nicaragua! (McNiel).

I find among the Guérin collection in the Museum of the Academy of Natural Sciences of Philadelphia, a specimen labelled "*Leptopodia vittata* Guer., Senegal." I have not been able to find any description of this species under that name, and possibly it was a MS. one. However I am unable to separate it from Floridan forms.

Genus **METOPORHAPIS** Stm.

Metoporhapis calcarata Stm.

Leptopodia calcarata Say, Journ. Acad. Phila., i. p. 445. Edw., Hist. Crust., i. p. 276.

Metoporhapis calcarata Stm., Ann. Lyc., vii. p. 198.

Nine specimens of this rare species were collected at Sarasota Bay and one young at Charlotte Harbor. The other localities

Specimens were collected at Sarasota Bay. Stimpson had it from St. Thomas and Tortugas. I have seen specimens from Key West (A. S. Packard, Jr.).

Sub-Family *Inachinæ* Miers.

Genus *CHORINUS* Leach.

Chorinus heros Leach.

Cancer heros Herbst, Krabben und Krebse, pl. 42, f. 1.

Chorinus heros Leach MS., M. Edw., Crust., i. p. 315. Von Martens, Arch. für Naturgesch., xxxviii. p. 80, pl. iv. f. 2.

Specimens in the Museum of the Peabody Academy (Florida, C. J. Maynard) afford the following measurements:—

Length of Carapax.	Breadth.	Ratio.
44 mm.	22.5 mm.	100 : 51
42 mm.	22. mm.	100 : 52

It has been reported from Key West (Gibbes), Cuba (Martens, A. M. Edw.), Antilles (M. Edw.), Martinique and Barbadoes (A. M. Edw.), Guadeloupe (Desbonne).

Sub-Family *Acanthonychinæ* Miers.

Genus *EPIALTUS* Edw

Epialtus longirostris Stm.

Epialtus longirostris Stm., Ann. Lyc., vii. p. 199. A. M. Edw., Crust. Mex. et Ant. Cent., p. 141, pl. xxvii, f. 5.

Two specimens of this species were collected at Sarasota Bay.

Epialtus minimus Lockington (Proc. California Acad., 1877, p. 7) is a closely allied species, and possibly both should be separated from the species with a shorter rostrum.

Key West (Stm.), St. Thomas (Stm., A. M. Edw.).

FAMILY *MAIDÆ*.

Sub-Family *Mallinæ*.

Genus *PELIA* Bell.

Pisa mutica Stm.

Pisa mutica Gibbes, Proc. Am. Assoc., iii. p. 171.

Pelia mutica Stm., Ann. Lyc., vii. p. 177. A. M. Edw., Crust. Mex. et Am. Cent., p. 73, pl. xvi. f. 2.

Specimens were collected at Northampton Co., Va., Beaufort, C., and Florida Bay, Fla. Prof. Gibbes' types were from

Charleston, S. C. Stimpson found it at Martha's Vineyard, Mass.
Dr. Packard collected specimens at Key West, Fla.!

FAMILY PERICHRIDÆ Miers.

Sub-Family Pericorinæ Miers.

Genus LIBINIA Leach.

Libinia dubia M. Edw.

Libinia dubia M. Edw., Hist. Crust., i. p. 800, pl. xiv bis, f. 2. Streets,
Proc. Phila. Acad., 1870, p. 104. A. M. Edw., Crust. Mex. et Am.
Cent., p. 129, pl. xviii, f. 5.

Libinia distincta, Guerin in de Sagra's Cuba, p. 12.

Northampton Co., Va., Morehead Depot and Beaufort, N. C.,
Little Sarasota Bay, Fla. Two males from the latter locality have
the following dimensions:—

Length of Carapax.	Breadth.	Ratio.	Length of 2d feet.
73 mm.	65 mm.	100 : 89	143 mm.
64 mm.	50 mm.	100 : 78	104 mm.

Other localities are Cape Cod to Florida (Smith); Nantucket,
Mass. (Packard), Long Island (Streets), Charleston, S. C. (Gib-
bes), Key West (Packard).

Libinia emarginata Leach.

Libinia emarginata Leach, Zoological Miscellany, iii. p. 120, pl. 106
(1815).

Libinia canaliculata Say, Jour. Phila. Acad., i. p. 77, pl. iv. f. 1.
M. Edw., Hist. Crust., i. p. 800. Dekay, N. Y. Fauna, Crustacea,
p. 2, pl. iv. f. 4.

Libinia affinis Randall, Jour. Phila. Acad., viii. p. 107, 1839.



Pisa bicorna Gibbes, Proc. Am. Assoc., iii. p. 170.

Pericera bicornata Guérin in Raman de Sagra, p. 12. Von Martens, Arch. für Naturgesch., xxxviii. p. 85, pl. iv. f. 4.

Pericera bicornis Sauss., Crust. Mex. et Antilles, p. 12, pt. i. f. 8.

Milnia bicornuta Stm., Ann. Lyc., vii. p. 180.

Microphrys bicornuta A. M. Edw., Mission Sci. Mex. et Am. Cent. Crust., p. 61, pl. xiv. f. 2-4.

Pisa galbica et *Pisa purpurea* Desbonne and Schramm, Crust. Guad., p. 18.

Omalaecantha hirsuta Streets, Proc. Phila. Acad., 1871, p. 288.

Specimens were collected at Plantation Keys, Florida Bay, Key West. Specimens from Plantation Keys gave the following measurements:—

Sex.	Length of Carapax.	Breadth.	Ratio.
♂	27.4 mm.	18.7 mm.	100 : 68
♂	31. mm.	21.2 mm.	100 : 68
♀	23. mm.	14.8 mm.	100 : 68

An examination of the single specimen which formed Streets' type of *Omalaecantha hirsuta*, which is preserved (in a dry state) in the Museum of the Philadelphia Academy, convinces me that Alphonse Milne Edwards was correct in supposing it a variety of *M. bicornutus*. It stands midway between the typical form (fig. 3, of A. Edw.) and that described by Desbonne as *Pisa galbica* (fig. 4, of A. Edw.). It, however, differs from both in a much smaller cheliped.

Tortugas (Stm.), Key West! (Packard), Antilles (Edwards, Saussure), Bermudas (Smith), Guadeloupe (Desbonne), Mexico (A. M. Edw.), Aspinwall! (McNiel), Desterro, Brazil (A. Edw.), Abrolhos, Brazil (Smith).

Genus **MACROCOLEMA** Miers.

Macrocaloma trispinosa Miers.

Pisa trispinosa Latreille, Encyc. Method, x. p. 142.

Pericera trispinosa M. Edw., Hist. Crust., i. p. 336. Von Martens, l. c., xxxviii. p. 84, pl. iv. f. 4. Schramm, Rev. et Mag. de Zool. III., ii. p. 342.

Pericera nodipes Desbonne and Schramm, op. cit., p. 15, pl. v. f. 13.

Macrocaloma trispinosa Miers, Jour. Linn. Soc'y, xiv. p. 665.

A single male was collected at Key West. Key West (Gibbes, Stm.), Tortugas (Stm.), Cuba (Martins), Guadeloupe (Desbonne).

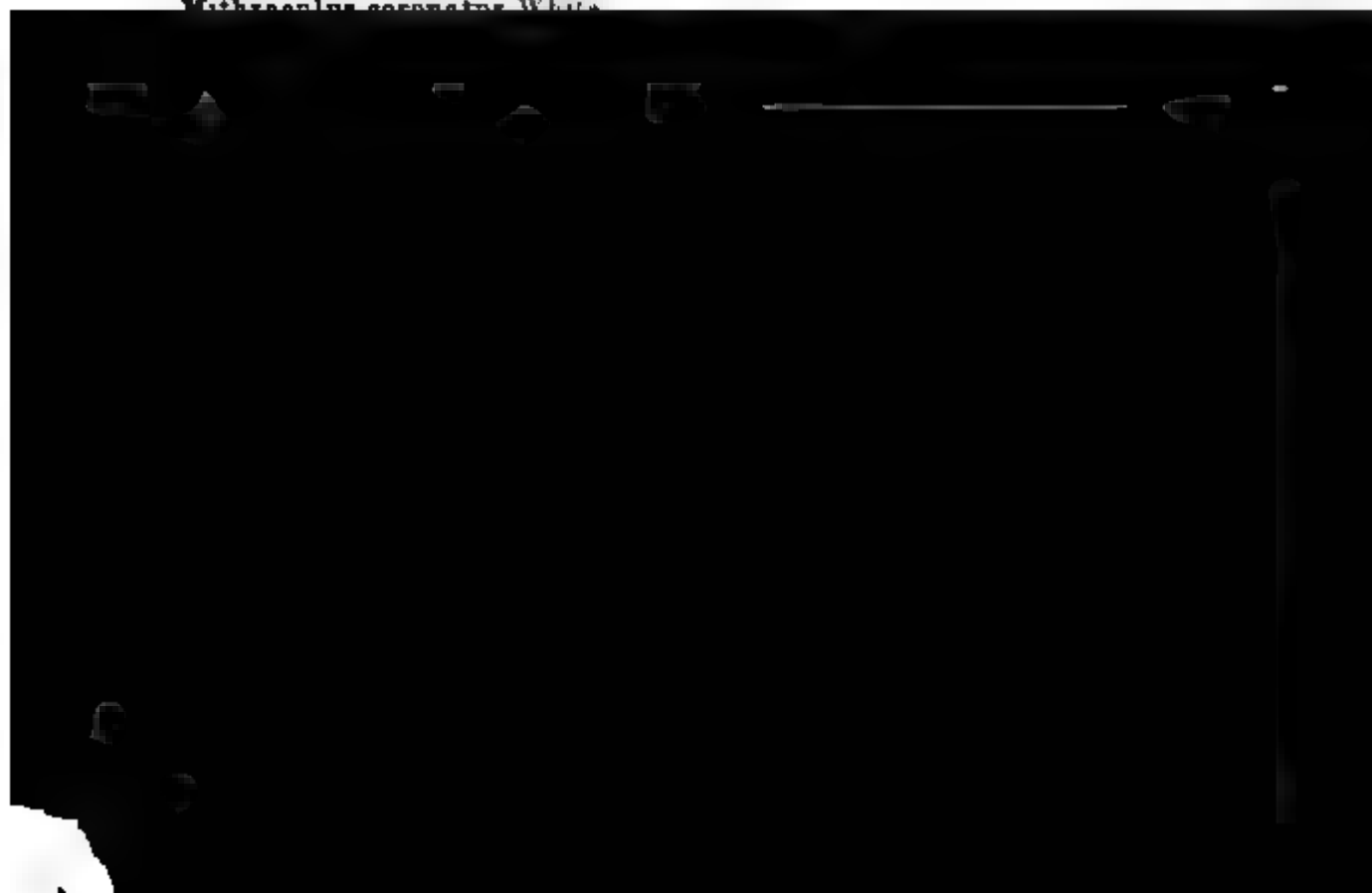
Sub-Family Othonilinae.

Genus OTHONIA,¹ Bell.*Othonia aculeata* Stm.*Hyas aculeatus* Gibbes, Proc. Am. Assoc., iii. p. 171.*Othonia aculeata* Stm., Ann. Lyc., vii. p. 49. A. M. Edw., Cross Mex. et Am. Cent., p. 115, pl. xxiv. f. 4.*Othonia therminieri* Desbonne and Schramm, op. cit., p. 20. A. M. Edw., op. cit., p. 116, pl. xxiv. f. 5.*Othonia anisodon* von Martens, l. c., xxxviii. p. 88, pl. iv. f. 2.

Professor Webster collected specimens of this species at Sarasota Bay and Harbor Key, Fla. I have examined others in the Museum of the Peabody Academy from Florida (C. J. Maynard) and Key West (A. S. Packard). I can see no constant differences to separate the forms described as *therminieri* and *anisodon* from typical forms. The teeth of the antero-lateral margin are variable, and differ frequently on the two sides of the same specimen. A young specimen from Sarasota Bay had but four teeth on the anterolateral margin besides the angle of the orbit, but I could find no other differences. In ten specimens the ratio of the length to the breadth ranged from 100 : 81 to 100 : 94, with an average of 100 : 86. Other localities are Key West (Gibbes, Stm.), Tortugas (Stm., A. M. Edw.), Cuba (Martens), Guadeloupe (Desbonne), St. Thomas (A. M. Edw.).

Sub-Family Mithracinae.

Genus MITHRACULUS White.

Mithraculus coronatus White

Other localities are Tortugas and Aspinwall, Abrolhos, Brazil (Smith), St. Thomas and Guadeloupe (A. M. Edw.).

***Mithraculus sculptus* Stm.**

Maia sculpta Lamarck, An. sans Vertebres, v. p. 242.

Mithrax sculptus Edw., Mag. de Zool., 1832, pl. v.; Hist. Crust. i. p. 323.

Mithraculus sculptus Stm., Am. Jour. II., xxix. p. 132. A. M. Edw., Crust. Mex. et Am. Cent., p. 105, pl. xx. f. 2.

Specimens were collected at Key West. I have seen others from the same locality collected by Dr. Packard, and from Tortugas (Lieut. Jacques). It has been reported from Antilles (Edw.), Cuba, Surinam, and Venezuela (Martens), Guadeloupe, St. Thomas, Martinique, Woman Key, Fla., and Cumana (A. Edw.).

***Mithraculus cinctimanus* Stm.**

Mithraculus cinctimanus Stm., Am. Jour. Sci. and Arts. II., xxix. p. 132 (sine descr.); Ann. Lyc., vii. p. 186. A. M. Edw., Crust. Mex. et Am. Cent., p. 112, pl. xxiii. f. 8.

The twelve specimens of this species that I have examined agree well with Stimpson's description, except in the coloration of the hands. In these specimens (alcoholic), the hands are white with the basal two-thirds darker; there is also a band of darker on the fingers. Prof. Webster collected specimens at Plantation and Harbor Keys. In the Peabody Academy are specimens from Key West (Packard). Other localities are Tortugas (Stm.), St. Thomas (Stm., A. Edw.), Guadeloupe (A. M. Edw.).

***Mithraculus hirsutipes* Kingsley. Pl. xiv. f. 1.**

Mithraculus hirsutipes Kingsley, Proc. Bost. Soc'y, xx. 147.

Two males were collected at Sarasota Bay, which agree well with my types, except in the comparatively narrower carapax.

Length of Carapax.	Breadth.	Ratio.
11 mm.	11.8 mm.	100 : 107
9 mm.	9.6 mm.	100 : 107

There were two young specimens collected at Sarasota Bay, which may be the young of either of the last two species. They differ, however, from *cinctimanus* in the absence of the large tooth at the base of the dactyli of the cheliped, and in having the ridge running backward from the palatal region broken; from *hirsutipes* in the smoother carapax, more prominent frontal horns, and in having the antennal spines as in *cinctimanus*, etc.

Genus **MITHRAX** Leach.**Mithrax spinosissimus** Edw.

Maia spinosissima Lamarck, An. sans Vert., v. p. 241.

Mithrax spinosissimus Edw., Mag. de Zool., li. pls. ii. and iii.; Hist. Crust., i. p. 321.

Two young specimens from Key West. Other localities are Martinique, Antilles (M. Edw.), Key West (Gibbes), Florida Keys (Stm.), Cuba (Martens), Santa Cruz! (Charles Lawrence), Guadeloupe (Desbonne).

Mithrax hispidus Edw.

Cancer hispidus Herbst, op. cit., pl. xviii. f. 100.

Maia spinicincta Lamarck, op. cit., v. p. 241.

Mithrax spinicincta Desmarest, op. cit., p. 150, pl. xxiii. f. 1, 2.

Mithrax hispidus Edw., Mag. de Zool., li.; Hist. Crust. i. p. 322. A.

M. Edw., Crust. Mex. et Am. Cent., p. 93, pl. xxi. f. 1.

Mithrax sp. Desbonne and Schr., op. cit., p. 8, pl. ii. f. 4 and 5.

Prof. Webster collected a single specimen of this well-known species at Key West. It has been reported from S. Carolina (Gibbes), Key Biscayne (Stm.), Key West! (Packard), Tortugas! (Lient. Jacques), Antilles (Edw.), Cuba (Martens), Guadeloupe (A. M. Edw., Desbonne, Saussure), Martinique (A. M. Edw.), Abrolhos, Brazil (Smith).

Mithrax pleuracanthus Stm.

Mithrax pleuracanthus Stm., B. M. C. Z., li. p. 116. A. M. Edw.

Crust. Mex. et Am. Cent., p. 93, pl. xx. f. 3.

Specimens were collected at Sarasota Bay. Stimpson's types were from Key West and St. Thomas. Alphonse Milne Edwards

Cuba (von Martens), Vera Cruz (A. M. Edw.), Guadeloupe (Desbonne and A. M. Edw.).

M. Alphonse Milne Edwards considers this the same as the *Lambrus serratus* described by H. Milne Edwards, and the description applies well to the specimen now before me. Milne Edwards, Sr., gives the Indian Ocean as the habitat of *L. serratus*, and Adams and White (Voyage of the Samarang, Crustacea, p. 80, 1841) report it from the Philippine Islands.

Sub-Family Cryptopodinae.

Genus **HETEROCRYPTA** Stm.

Heterocrypta granulata Stm.

Cryptopodia granulata Gibbes, Proc. Am. Assoc., lii. p. 173; Proc. Elliot Soc'y, i. p. 36 (fig.).

Heterocrypta granulata Stm., Ann. Lyc., x. p. 102. A. M. Edw., Crust. Mex. et Am. Cent., p. 186, pl. xxix. f. 4.

Specimens were collected at Northampton Co., Va.; near Piver's Island, Beaufort, N. C., Florida Bay, and Sarasota Bay. Fort Macon! (Packard), Charleston, S. C. (Gibbes), St. Thomas (Stm., A. M. Edw.).

CANCROIDEA.

FAMILY CANCRIDÆ.

Sub-Family Canorinae.

Genus **CANCER** Leach (restr.).

Cancer irroratus Say.

Cancer irroratus Say, l. c., l. p. 59 (pars), pl. iv. f. 8.

Platycarcinus irroratus Edw., Hist. Crust., i. p. 414.

Cancer sayi Gould, Invert. Mass., p. 828.

Platycarcinus sayi Dekay, N. Y. Fauna Crust., p. 7.

Platycarcinus irroratus Dekay, op. cit., pl. ii. f. 2.

Cancer borealis Packard, Memoirs Bost. Soc'y, i. p. 803.

A young specimen was taken at Northampton Co., Va. It was rather more advanced than the form described by Prof. Smith (Fish Comm., p. 533); the length was 5 mm., breadth 6 mm.; the front is more produced, and the teeth of the anterolateral margin are more irregular than in the adult, but not to such an extent as in the younger form. I have not thought it worth while to enumerate all the reported localities for this species. I have examined specimens from Labrador (Packard), Eastport, Me. (Hyatt),

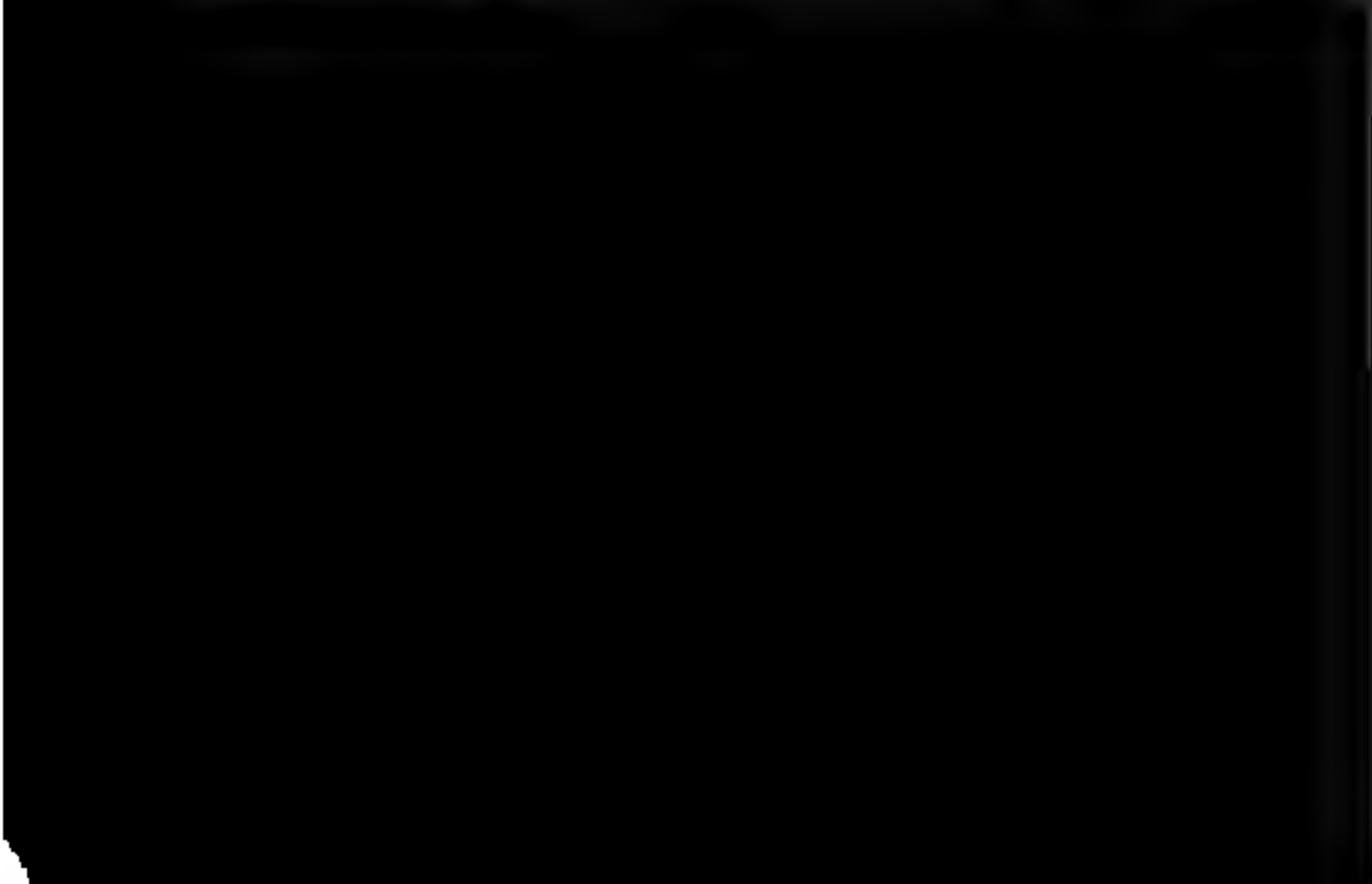
Casco Bay (Cooke), Is. of Shoals (R. H. Wheatland), Salem, Mass., Nantucket (Packard), Narragansett Bay, R. I., So. Shore, Long Island. Dr. Coues reports it from Fort Macon, Prof. Gibbs from Charleston Harbor, S. C., and Mr. Faxon writes me that there are specimens in the Museum of Comparative Zoology, at Cambridge, Mass., from Florida and Hayti (Dr. Weinland). In the Museum of the Peabody Academy of Science, Salem, Mass., is a fossil carapax of this species from the Post Pleiocene deposits of Gardiner, Maine.

Sub-Family Xanthinæ.

Genus *ACTEA* De Haan.

Actea spinifera, sp. nov.

Closely resembles *A. hirsutissima*, of the eastern seas, as figured and described by Rüppell¹ and Dana.² Carapax everywhere above areolate, more prominently so in front. Each areolet with small prominent rounded tubercles, which are covered with numerous stiff hairs, the spaces between the tubercles and between the areolets are smooth and naked; front with two depressed and produced lobes, the margins of which are armed with tuberculiform teeth; orbits with traces of two fissures above, spined above and below. Antero-lateral margins with five subequal teeth separated by rather deep grooves, the first three of which are continued on the under surface of the carapax; the teeth themselves have their margins armed with small spines. The postero lateral margin is strongly concave, as much so as in *A. hirsutissima*. Cheliped stout, of moderate length, inner surface of the joints smooth and



Abdomen and sternum granulate, the granulations being more prominent on the basal joints of the abdomen.

A single male was collected at Plantation Key, from which I derive the following measurements: Length, 14.2 mm.; breadth, 21 mm.; ratio, 100 : 148. This species is readily separated from all other North American species by the spines on the anterolateral teeth.

***Actæa nodosa* Stm.**

Actæa nodosa Stm., Ann. Lyc., vii. p. 203. A. M. Edw., Nouv. Arch. du Mus., i. p. 266, pl. xvii. f. 6.

A specimen from Plantation Key affords the following measurements: Length, 17.5 mm.; breadth, 23.7 mm.; ratio, 100 : 135.

Tortugas (Stm.), Guadeloupe (Desbonne).

Genus **MENIPPE** De Haan.

***Menippe mercenaria* Stm.**

Cancer mercenaria Say, l. c., i. p. 448.

Cancer (Xantho) mercenaria Edw., Hist. Crust., i. p. 399.

Pseudocarcinus ocellatus Edw., Hist. Crust., i. p. 409 (?).

Pseudocarcinus mercenaria Gibbes, Proc. Am. Assoc., iii. p. 176.

Menippe mercenaria Stm., Ann. Lyc., vii. p. 53.

Menippe ocellata Von Martens, l. c., xxxviii. p. 87.

Prof. Webster collected specimens of this well-known but synonymically abused species at Beaufort, N. C., Florida Bay, Plantation Key, Charlotte Harbor, Oyster Bay, Little Sarasota and Sarasota Bays.

Other localities are Fort Macon! (Coues, Packard), Charleston, S. C. (Gibbes), Key West! (Packard), Isthmus of Panama (Streets), Cuba (Martens). Mr. Faxon tells me there are specimens in the Museum of Comp. Zoology from Cuba (Poey), and Galveston, Texas (Boll).

Genus **PANOPEUS** M. Edw.

***Panopeus herbstii* Edw.**

Cancer panope Say, Jour. Acad. Nat. Sci. Philadelphia, i. p. 58, pl. iv. f. 5 (nec Herbst).

Panopeus herbstii Edw., Hist. Crust., i. p. 408. Dekay, op. cit., p. 5, pl. ix. f. 26. Smith, Proc. Bost. Soc'y, xii. p. 276.

Occurs in this collection from Northampton Co., Va., Beaufort, N. C., Sarasota, Little Sarasota, Florida, and Oyster Bays, and Charlotte Harbor, Florida. Other localities are Fort Macon, N.

C. I (Packard), Bluffton, S. C. I (Dr. Mellichamp), Key West I (Packard), Aspinwall I (McNiel), Long Island Sound and Bahamas (Smith), Cuba (Martens), Rio Janeiro (Heller). According to Mr. Faxon there are specimens in the Museum of Comparative Zoology from Boston (Gould?, 1853) and Providence River, R. I.

Panopeus packardii Kingsley.

Panopeus packardii Kingsley, Proc. Bost. Soc'y, xx. p. 152.

Specimens occur from Sarasota Bay, Harbor Key, and Charlotte Harbor, Fla. The majority of these specimens have the sinus between the angle of the orbit and the second normal tooth more shallow than did my types, which were from Key West (Packard).

Panopeus texanus Stimpson.

Panopeus texanus Stm., Ann. Lyc., vii. p. 55.

Panopeus sayi Smith, Proc. Bost. Soc'y, xli. p. 284.

Specimens occur in the Union College collection from Northampton Co., Va., Beaufort, N. C., and Sarasota Bay, Fla. I have also seen specimens from Eastham, Mass. (W. C. Fish), Wood's Holl, Mass. (Packard, Verrill), New Haven, Conn. (Yale College). A careful examination of a large series has led me to unite these two forms, as I cannot find constant differences to separate them. There is all variation in the subhepatic tubercle, from one as prominent as typical specimens of *P. herbstii* to complete absence; the form of the anterolateral teeth varies, while the terminal segment of the male abdomen is the same in each form; in some the fingers of both hands were slender, some had them pointed on one hand and excavate on the other, while others had the fingers of both hands excavate. I am therefore ready to unite them, and

Prof. Webster collected specimens at Sarasota and Little Sarasota Bay, Fla. Other localities, New York (Dekay), So. Carolina (Gibbes, Stm.), Key West, Fla. (Packard), Smyrna, Fla. (Gibbes), Key Biscayne, Fla. (Stm.). Mr. Faxon tells me that there are specimens in the Museum of Comparative Zoology from Hayti (Dr. Weinland) and Brazil (Thayer Expedition).

Genus **CHLORODIUS** Leach.

Chlorodius floridanus Gibbes.

Chlorodius floridanus Gibbes, l. c., iii. p. 175.

Leptodius floridanus A. M. Edw., Hist. Crust. Fossiles, i. p. 228.

But a single specimen of this common species was collected by Prof. Webster, at Plantation Key, Fla. I have examined others from Key West (Packard), Aspinwall (McNiel), and Abrolhos, Brazil (Hartt).

Chlorodius longimanus M. Edw.

Chlorodius longimanus M. Edw., Hist. Crust., i. p. 401.

A single specimen was collected at Key West, by Prof. Webster.

I have seen others from the same locality collected by Dr. A. S. Packard, which differ from Edwards's description in having the meros of the chelipeds armed with five distant tuberculiform teeth. Edwards's specimens were from Porto Rico.

Chlorodius dispar Stm

Chlorodius dispar Stm., B. M. C. Z., ii. p. 140.

Eighteen specimens were collected at Key West, and as they show a considerable range of variation, I give a description of a specimen varying most widely from Stimpson's type.

Carapax transversely oval, very broad, smooth, naked; anterolateral margin almost entire, the three last teeth alone showing, and they but very slightly. Front sinuate, four lobed, resembling that of *Panopeus herbstii*, a straight fringe of hairs above the margin. Orbits entire above and below, the inner inferior angle prominent. Chelipeds long, about equal in length, but differing greatly in diameter, the right being usually the larger. Fingers of the larger about half the length of the palm, short, stout, gaping, with the extremities acute, not at all excavate. Smaller cheliped, with the carpus and propodus polished and deeply punctate. Hand long, no stouter than the preceding joint, subcylindrical, fingers about half as long as the palm, closing completely,

and spoon excavate. Smaller specimens agree perfectly with Stimpson's description, while the smallest specimen has all the antero-lateral teeth obsolete.

Sex.	Length of Carapax.	Breadth.	Ratio.
♂	7.8 mm.	18.2 mm.	100 : 169
♂	8.9 mm.	5.5 mm.	100 : 149

Stimpson's types, two in number, were from Cruz del Padre, Cuba.

FAMILY ERIPHIDÆ Dana.

Sub-Family Oxilinae Dana.

Genus HETERACTEA Lockington.⁴

In the two species which I have examined the following characters may be noted. Form similar to that of *Pilumnus*, which it closely resembles in the antennæ and external maxillipeds. It, however, differs in the absence of a palatal ridge and in the curious naked crests on the meral joints of the ambulatory feet. The orbits have the external hiatus more or less distinct, and below have two lobes. It forms one of these synthetic forms, which like *Xanthodius*, *Eurytium*, *Eurycarcinus*, *Pilumnopeus*, *Micropanope*, etc., combine the characters of both Cancroid and Eriphioid Crustacea. The type is *Heteractea lunata*.¹

Heteractea ceratopus Kingsley.

Pilumnus ceratopus Stm., Ann. Lyc., vii. p. 215.

Pilumnus sp. Desbonne et Schramm., op. cit., p. 83, pl. iii. f. 9-10.

A male was collected at Key West, Fla. Key Biscayne, Fla.

Specimens were collected at Sarasota Bay and Marcou Pass.

***Pilumnus dasypodus* Kingsley.**

Pilumnus dasypodus Kingsley, Proc. Bost. Soc'y, xx. p. 155.

Harbor Key and Sarasota Bay, Fla. My types were from Key West.

***Pilumnus gemmatus* Stm.**

Pilumnus gemmatus Stm., Ann. Lyc., vii. p. 214.

Specimens were collected at Plantation and Harbor Keys, Charlotte Harbor, and Florida Bay. I have seen others from Key West (Packard). Stimpson's types were from St. Thomas.

Genus **EUPILUMNUS** (nov.).

Carapax depressed. Basal joints of antennæ as in *Pilumnus*. External maxillipeds with the meral joint short and narrow, it being only about two-thirds as wide as ischial joint, which is short and broad.

***Eupilumnus websteri*, sp. n., plate xiv. f. 3.**

Carapax depressed, nearly flat, regions not indicated, above with a short, sparse pubescence, front slightly arcuate, the margin with fine spiniform teeth. Orbits above smooth, not toothed. External angle spiniform, below with spines near the inner angle. Antero-lateral margin with three prominent spiniform teeth, with smaller ones between them, several small spines on the hepatic region, and one on the branchial behind the lateral teeth. Anterior margin of palate spined. The chelipeds are lacking in the single specimen. Ambulatory feet compressed, spined above, dactyli short, curved, spined below.

Key West, Fla. Length, 6 mm.; breadth, 8.1; ratio, 100 : 135.

Sub-Family **Eriphiinæ** Dana.

Genus **ERIPHIA** Latreille.

***Eriphia gonagra* M. Edw.**

Cancer gonagra Fabr., Suppl. Ent. Syst., p. 337.

Eriphia gonagra Edw., Hist. Crust., i. p. 426, pl. xvi. f. 16, 17.

Specimens were collected at Plantation Key, Fla. Other localities are Key West! (Packard), Tortugas (Stm.), Florida Keys, Bahamas (Smith), Aspinwall! (McNiel), Abrolhos, Brazil! (Hartt), Rio Janeiro (Dana, Heller), Cuba (von Martens), Jamaica et Carolina (Bosc).

FAMILY PORTUNIDÆ.

Sub-Family Lupinæ.

Genus ACHELOUS De Haan, Stm.

Achelous spinimanus De Haan.

Portunus spinimanus Latr., Encyc. Methodique, x. p. 189.

Lupa spinimana Desmarest, op. cit., p. 98. Edw., Hist. Nat. Crust.,
i. p. 452.

Achelous spinimanus De Haan, Fauna Japonica Crust., p. 8. A. M.
Edw., Archives du Museum, x. p. 341, pl. xxxii. f. 1.

Little Sarasota Bay.

Achelous gibbesii Stm.

Lupa gibbesii Stm., Ann. Lyc., vii. p. 57.

Achelous gibbesii Stm., Ann. Lyc., vii. p. 222.

Neptunus gibbesii, A. M. Edw., Nouv. Archives du Museum, x. p.
326, pl. xxxi. f. 1.

Beaufort, N. C.; Oyster Bay and Sarasota Bay, Fla. The range
of this species so far as known is included within the limits of the
above localities.

Genus CALLINECTES Stm.

Callinectes hastatus Ordway.

Lupa hastata Say, l. c., i. p. 65.

Lupa diacantha Dekay, op. cit., p. 10, pl. iii. f. 3.

Callinectes hastatus Ordway, Jour. Bost. Soc'y, vii. p. 569.

Three sterile females were collected at Beaufort, N. C.

Genus NEPTUNUS De Haan.

Neptunus sayi Stm

Carcinus maenas Leach, op. cit., vii. p. 429 (teste Auct.); Malacos.

Podophth. Brit., pl. v. f. 1-4. Dekay, op. cit., p. 8, pl. v. f. 5-6.

Alph. M. Edw., Arch. du Mus., x. p. 391.

Cancer granulatus Say, l. c., i. 61.

Carcinus granulatus Smith, Fish Comm., p. 547.

A single male from Northampton Co., Va. This is the farthest south on the Atlantic coast of the United States from which this species has been reported.

Genus **PLATYONICHUS** Latreille.

Platyonichus ocellatus (Herbst sp.) Latreille.

Portunus pictus Say.

Beach of Chesapeake Bay, opposite Fort Monroe. Mr. James Hector (Trans. New Zealand Inst., ix. p. 473, pl. xxviii. f. 1, 1877) reports this species from Wellington, New Zealand.

OCYPODOIDEA.

FAMILY **CARCINOPLACIDÆ**.

Genus **EURYPLAX**.

Euryplax nitida Stm.

Euryplax nitida Stm., Ann. Lyc., vii. p. 60; B. M. C. Z., ii. p. 150.

Smith, Trans. Conn. Acad., ii. p. 162.

Specimens collected by Prof. Webster, at Sarasota Bay, Fla., have the front slightly arcuate with a slight sinus at the middle, but not emarginate. The carpi of the chelipeds are not flattened. Otherwise the specimens agree perfectly with the descriptions quoted above. Proportions of a male: length, 14.7 mm.; breadth, 23.5 mm.; ratio, 100:160. There is a single specimen in the Museum of the Peabody Academy of Science, which came with *Platyonichus ocellatus*, *Squilla empusa*, and two or three other species with the label New Orleans. Other localities are Florida Keys and St. Thomas (Stm.), Egmont Key, Fla. (Smith).

FAMILY **OCYPODIDÆ**.

Genus **GELASIMUS** Latr.

Gelasimus minax Le Conte.

Northampton Co., Va.

Gelasimus pugillator (Bosc sp.) Latreille.

Beaufort, N. C., and Sarasota Bay, Fla.

FAMILY GRAPSIDÆ.

Sub-Family Grapsinæ.

Genus GONIOPSIS De Haan, Edw.

Goniopsis cruentatus De Haan.

Cancer ruricola De Geer, Mémoires pour servir à l'Histoire naturelle des Insectes, vii. p. 417, pl. xxv. (non Linne).

Grapsus cruentatus Latreille, Hist. Crust. et Insect. Hist. Crust., ii. p. 85.

Grapsus longipes Randall, l. c., vii. p. 125.

Goniopsis cruentatus De Haan, Fauna Japonica, p. Sci. Nat. III., xx. p. 164, pl. vii. f. 2.

Goniopsis ruricola White, List Crust. Brit. Museum, op. cit., p. 80, pl. ii. f. 18.

Goniograpsus cruentatus Dana, U. S. Expl. Exped., pl. xxi. f. 7.

Grapsus (Goniopsis) cruentatus von Martens, l. c.,

A male was collected at Sarasota Bay. Other specimens from Florida Keys (Smith), Cuba (Saussure, Martens), (M. Edw.), Guadeloupe (Desbonne), Surinam (Randall), Liberia (Martens), Abrolhos, Brazil (Smith), Rio de Janeiro (Heller), ? Gulf of Fonseca, west coast of Nicaragua.

Genus PACHYGRAPSUS Randall.

Pachygrapsus transversus Gibbes.

Grapsus transversus Gibbes, l. c., iii. p. 181.

Cuba (Martens), Gulf of Fonseca, west coast Nicaragua! (McNiel), Panama (Smith).

Genus **GRAPSUS** Lamarck.

Grapsus maculatus Edw.

Pagurus maculatus Catesby, Natural History of the Carolinas, ii. pl. xxxvi. f. 1. 2d edit., l. c.

Cancer grapsus Fabr., Suppl., p. 342.

Grapsus pictus Latr., Hist. Crust. et Ins., vi. p. 69, pl. 47, f. 2.

Goniopsis pictus De Haan, Fauna Japonica, Crustacea, p. 33 (1833).

Grapsus maculatus M. Edw., Am. Sci. Nat. III., xx. p. 167, pl. vi. f. 6.

Grapsus altifrons Stm., Ann. Lyc., vii. p. 230.

Specimens were collected at Plantation Key, Fla. According to Martens, the *Cancer tenuicristata* of Herbst, on examination of his types, proves to be *Grapsus rudis*, Edw., from the East Indies.

Santa Cruz! (Charles, Lawrence), Cuba (Saussure, Martens), Guadeloupe (Desbonne), Tortugas (Stm.), Madiera, Cape Verdes, Peru, Paumotu Is., Sandwich Is. (Dana), C. St. Lucas (Stm.), Mazatlan (Saussure), Gallapagos Is. (Miers), Chili (Nicolet), Tahiti! (A. Garrett).

Genus **PLAGUSIA** Latreille, Miers.

The species of this genus have been recently revised by Mr. Miers (Ann. and Mag. Nat. Hist., Feb. 1878, pp. 147-154).

Plagusia depressa Say.

?*Cancer depressus* Fabr.; ?*Cancer squamosus* Herbst; *Plagusia sayi* Dekay; *Plagusia squamosa* Latr.; *Plagusia gracilis* Sauss.

A single specimen (length 42.2, breadth 45.2 mm.) was found at Plantation Key.

Sub-Family **Sesarminæ**.

Genus **SESARMA** Say.

Sesarma cinerea Say.

Grapsus cinereus Bosc, op. cit., edit. 1, p. 204, pl. v. f. 1 (teste auct.).

Sesarma cinerea, Say, l. c., i. p. 442 (non *Grapsus cinereus*, p. 99), Edw., Hist. Crust., ii. p. 75.

Northampton Co., Va., Beaufort, N. C., Sarasota and Little Sarasota Bays, Florida.

Sesarma reticulata Say.

Sesarma reticulata Say, l. c., i. pp. 73, 76, 442, pl. iv. f. 6; Edw., Ann. Sci. Nat., III. xx. 182.

Sesarma cinerea Dekay, op. cit., p. 15.

Northampton Co., Va., and Little Sarasota Bay, Fla.

Genus **ARATUS**.

Aratus pisonii M. Edw.

Sesarma pisonii M. Edw., Hist. Crust., ii. p. 76, pl. xix. f. 4-6.

Aratus pisonii M. Edw., Ann. Sci. Nat., II. xx. p. 187; Stm., Ann. Lyc., vii. p. 282.

Sesarma (Aratus) pisonis von Martens, Wieg. Arch., xxxv. p. 12, pl. 1, f. 4 (1869); id., xxxviii. p. 111.

Specimens were collected at Sarasota Bay, Florida. It ranges south to Rio Janciro (Heller). I am unable to separate specimens from the west coast of Nicaragua (McNeil) from the east coast forms.

FAMILY PINNOTHERIDÆ.

Genus **PINNOTHERES**.

Pinnotheres ostreum Say.

Pinnotheres ostreum Say, l. c., i. p. 67, pl. iv. f. 5.

Beaufort, N. C.

Pinnotheres maculatus.

Pinnotheres maculatus Say, l. c., i. p. 450.

Pinnotheres ostreum Smith, Fish Commission, pl. i. f. 2.

Beaufort and Morehead Depot, N. C.

Genus **PINNIXA** White.

Pinnixa cylindrica White.

Pinnotheres cylindrica Say, l. c., i. p. 452.

Pinnixa cylindrica White, Hist. Crust. Brit. Mus., p. 33; Ann. and Mag. Nat. Hist., xviii. p. 177; Smith, Fish Comm., p. 546, pl. 1, f. 1.

Pinnixa laevigata Stm., Ann. Lyc., vii. p. 68.

Specimens were collected at Florida and Sarasota Bays, Fla.

Prof. Webster collected specimens at Beaufort, N. C., Key West, and Sarasota Bay, Fla. Other localities are Antilles (Auct.), Pensacola, Tortugas, and Key West (Stm.), Charleston, S. C. (Gibbes), Cuba (Martens), Bermudas (Goode), Guadeloupe (Desborne). Mr Faxon tells me he has taken specimens at Newport, R. I.

FAMILY MATUTIDÆ.

Genus **HEPATUS** Latreille.

Hepatus decorus Gibbes.

Cancer decorus Harbst, op. cit., p. 154, pl. xxxvii. f. 6.

Hepatus decorus Gibbes, Proc. Am. Assoc., iii. p. 183.

Hepatus vanbenedeni Herklots, Bidjr. tot de Dierkunde, I. p. 85, pl. 1, f. 1 (1852).

Specimens were collected at Beaufort, N. C., Charlotte Harbor, Marcon Pass, and Sarasota Bay, Fla. Dr. Stimpson suggests a comparison of the young of this species with *H. tuberculatus* Saussure, but, on examination, the difference is as great as in the adult.

FAMILY LEUCOSIDÆ.

Sub-Family **Ilinae**.

Genus **PERSEPHONE**.

Persephone punctata Stm.

Cancer punctata Brown, Natural History of Jamaica, pl. 42, f. 3.

Persephone latreillei et *P. lamarckii* Leach, Zool. Mis., iii. p. 22.

Guaia punctata Edw., Hist. Crust., ii. p. 127.

Persephone guaia Bell, Trans. Linn. Soc'y, xx. p. 293.

Persephone punctata Stm., Ann. N. Y. Lyc., vii. p. 70.

Beaufort, N. C., Sarasota and Florida Bays, Fla.

Sub-Family **Eballinae**.

Genus **LITHADIA**.

Lithadia cariosa Stm.

Lithadia cariosa Stm., Ann. Lyc., vii. p. 238.

Beaufort, N. C., Harbor Key, Fla., and Sarasota Bay, Florida. The Floridan forms have a less irregular carapax, but otherwise I can detect no difference.

Lithadia lacunosa, sp. n.

Carapax convex, with small circular depressions, similar in form and appearance to those on a lady's thimble. Closely re-

sembling *L. cariosa* in form. Inner portions of branchial and cardiac regions moderately protuberant. Hepatic region but slightly excavate, the ridge crossing it being broad, low, and rounded, otherwise as in *L. cariosa*. Front elevated, and connected with cardiac region by a broad rounded ridge (in *cariosa* this ridge is narrow and more abrupt); a small tooth on the postero-lateral margin. The sulcus separating the cardiac from the branchial region is well marked, but not so much as in *cariosa*. Chelipeds with small tubercles. Abdomen of the male with a strong tooth directed backward, arising from the proximal margin of the penult joint.

A male from Sarasota Bay gives the following measurements: Length of carapax 9.7 mm., breadth 11.1 mm., ratio 100 : 135.

This species differs from *cariosa* in the broader carapax, the ornamentation, and more even surface; from *pontifera* in lacking the "bridged" fossæ between the cardiac and brachial regions; from *cadaverosa* in more even carapax and ornamentation, and in having but one tooth on the antero-lateral margin; from *cubensis* in having the meros of the chelipeds subcylindrical, and not expanded behind.

DROMIOIDEA.

FAMILY DROMIIDÆ.

Genus DROMIDIA Stm.

Dromidia antillensis Stm.

Dromidia antillensis Stm., Proc. Phila. Acad., 1858, p. 225; Ann. Lyc. vli p. 71

that the two posterior pairs of feet and the projecting abdomen each do their part.

PORCELLANOIDEA.

FAMILY PORCELLANIDÆ.

Genus PETROLISTHES Stm.¹

Petrolisthes scarpinosus Stm.

Porcellana galathina Say, l. c., i. p. 458 ? (non Bosc).

Porcellana scarpinosa Gibbs, Proc. Am. Assoc., iii. p. 190.

Petrolisthes scarpinosus Stm., Proc. Phila. Acad., 1858, p. 227.

Professor Webster collected specimens at Key West, Harbor Key, Florida Bay, and Sarasota Bay.

I am inclined to follow Stimpson in supposing that this is not the *Porcellana galathina* of Bosc, as it differs considerably from his figure, which represents a species with smaller hands, shorter fingers, the ridges of the carapax different, while the carapax itself is nothing like that of this species. This species has been reported from Georgia and Florida (Say), South Carolina and Key West (Gibbs) and Florida Keys (Stm.).

Petrolisthes jugosus Streets.

Petrolisthes jugosus Streets, l. c., 1872, p. 134.

I refer, with a doubt, a single specimen collected at Key West to this species, as it presents the following points of difference from Dr. Streets' description: The lobes of the front are indistinct. (The right hand is missing.) The posterior border of the hand is not pubescent, and there is no trace of a furrow on the upper portion of the hand; the anterior margin of the carpus has four teeth. In every other respect it agrees perfectly. Dr. Streets' specimens came from the Island of St. Martins, W. I.

¹ I would here straighten the synonymy of two species of this genus—

Petrolisthes dana

Porcellana dana Dana, U. S. Expl. Exped. Crust., p. 421, pl. xxvi. f. 2 (non Savigny).

Porcellana dana Gibbs, Proc. Elliot Soc'y, i. p. 11.

Petrolisthes braziliensis Smith, Trans. Conn. Acad., ii. p. 38.

(Rio Janeiro - Dana).

Petrolisthes Heller.

Porcellana dana Heller, Reise der Oesterreich Fregatte Novara. Crustaceen, p. 74 (non Gibbs).

(Niobara Heller)

***Petrolisthes armatus* Stm.**

Porcellana armata Gibbes, Proc. Am. Assoc., iii. p. 90; Proc. Elliot Soc'y, i. f. 11, pl. i. f. 4; Martens' Wieg. Arch., xxxviii. p. 121, pl. v. f. 11.

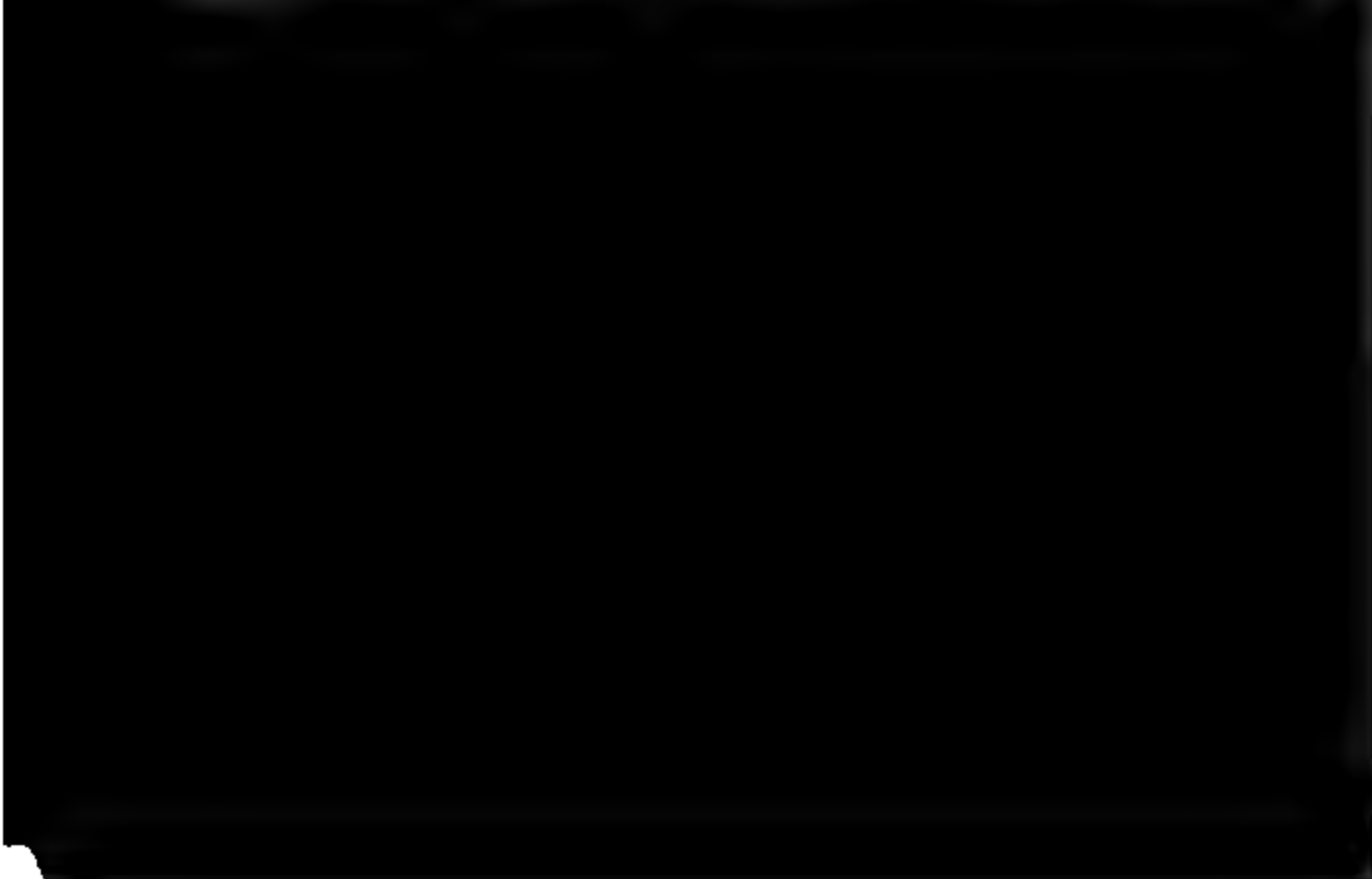
Petrolisthes armatus Stm., Proc. Phila. Acad., 1858, p. 227, vii. p. 72.

Specimens were collected at Sarasota, Charlotte, and Florida Bays. Other localities are Key West! (Packard), Florida (Gibbes), Aspinwall, St. Thomas, and Panama (Stm.), Cuba (Martens), Fonseca, west coast Nicaragua! (McNiel), Gulf of California (Lockington).

Dr. von Martens quotes *P. galathina* Bosc as a synonym of this species, which is surely erroneous.

Genus *PLEOSOMA* Stm.***Pleosoma glabra*, sp. n. Plate xlv. fig. 2.**

Carapax convex, a little broader than long, polished, microscopically punctate. Front advanced, broad, three lobed, the median lobe being slightly more advanced than the lateral ones. Antennæ about twice as long as the carapax, the basal joints similar to those of *Petrolisthes*. Chelipeds short, stout; meros subcubical, its anterior margin distally armed with an acute tooth directed toward the carpus; carpus stout, broader than long, its anterior margin expanded, with a strong tooth on the proximal portion, the remainder with rounded teeth, the posterior portion of the upper surface is roughened, and the posterior margin distally armed with minute rounded teeth. Hand twice as long as broad, microscopically granulate, a shallow sulcus on the posterior por-



short stiff hairs arranged in transverse rows. Front advanced, three-lobed, median lobe projecting beyond the others. Chelipeds short, stout, unequal, and clothed above with a short pubescence, interspersed in which are stiff hairs, similar to those of the carapax. Carpus short, length and breadth about equal, the inner margin expanded, and armed with four or five acute teeth. Hands short and broad, almost sub-chelate, the thumb being very short, and the dactylus strongly curved. Ambulatory feet with pubescence and hairs similar to those on the carapax.

Specimens were collected at Sarasota Bay and Key West.

Length of Carapax.	Breadth.	Ratio.
4 mm.	5.1 mm.	100 : 128
6 mm.	6.2 mm.	100 : 103

Edwards's specimens were from Charleston, S. C.

Porcellana sayana.

Pisidia sayana Leach, Dict. Sci. Nat., xviii. p. 54.

Porcellana ocellata Gibbes, Proc. Am. Assoc., iii. p. 190. Ibid., Proc. Elliot Soc., i. p. 12, pl. i. f. 2.

Quite a number appear in this collection from Sarasota Bay. Gibbes' types came from South Carolina; Stimpson reports it from Fort Macon, N. C., Florida Keys, and St. Thomas.

At my request Mr. Edward J. Miers very kindly examined Leach's type in the British Museum, which was sent by Say under the name *Porcellana galathina*. He says: "Leach's specimens of *Porcellana (Pisidia) sayana* are certainly not referable to *P. sexspinosus*, as described by Gibbes, but appear to belong to *P. ocellata* of the same author. They agree well with Gibbes' description and with specimens of *P. ocellata* received by the British Museum from the Smithsonian Institution, differing only in being of smaller size and in no longer presenting any traces of the pink reticulations."

***Porcellana sociata* Say.**

Porcellana soriata Say, Journ. Phila. Acad., i. p. 456.

Pisidia socia Leach, Dict. Sci. Nat., xviii. p. 54.

Porcellana sociata Gibbes, Proc. A. A. A. S., iii. p. 190. Ibid., Proc. Elliot Soc., i. p. 12, pl. i. f. 6.

Professor Webster collected specimens at Florida Bay and Harbor Key. Other localities are Fort Macon (Stm.), South Carolina, and Key West (Gibbes), Georgia, and Florida (Say, Leach).

Genus **POLYONYX** Stm.**Polyonyx macrocheles** Stm.

Porcellana macrocheles Gibbes, Proc. Am. Assoc., iii. p. 191. *Ibid.*,
Proc. Elliot Soc., i. p. 6, pl. i. f. 5.

Polyonyx macrocheles Stm., Proc. Phila. Acad., 1858, p. 229. Faxon,
B. M. C. Z., v. 256, pls. II. and III. (Development).

In this species the males are smaller, with a narrower carapax and with the chelipeds proportionately longer than in the female, as will be seen by the following measurements:—

Locality.	Sex.	Length.	Breadth.	Ratio.	Length of Larger Hand.
Sarasota Bay	♀	8.2 mm.	18.2 mm.	100 : 161	23.2
"	♀	7.5 mm.	12 mm.	100 : 160	23
"	♂	5.5 mm.	7.6 mm.	100 : 138	20.4
"	♂	6.4 mm.	9.2 mm.	100 : 144	24.5
Beaufort, N. C.	♂	6 mm.	9 mm.	100 : 150	23.7

According to Prof. Webster's labels, this species was found at Beaufort, N. C., and Shark Shoal, N. C., in tubes of *Chaetopterus*, as was noticed by Stimpson. Stimpson and Gibbes had specimens from South Carolina. Newport, R. I. (Faxon).

Genus **EUCRAMUS** Stm.**Eucramus praelongus** Stm. Plate xiv. fig. 4.

Eucramus praelongus Stm., Am. Journ. Sci. and Arts, II. xxix. p. 445.

Professor Webster obtained specimens of this curious crustacean at Beaufort, N. C. (7 faths.), and Florida and Sarasota Bays, Fla., from which the following description is drawn:—

domen and its appendages resembling those of the allied genera, but narrower. Length of carapax 12 mm., breadth 6 mm., ratio 100 : 50.

Genus **HIPPA** Fabr., Edw.

Hippa emerita Fabr.

? *Cancer emerita* Linne, Syst. Nat. Ed., xii. p. 1055.

Cancer testudinarius Herbst, pl. xxii. f. 3.

Hippa emerita [us] Fabr., Suppl. Ent. Syst., p. 370. Desmarest Consid., p. 174, pl. xxix. f. 2. Edw. Hist. Crust., ii. p. 209. Dana, U. S. Ex. Crust., p. 409, pl. xxv. f. 9. Miers, Journ. Linn. Soc., xiv. p. 313, pl. v. f. 9.

Hippa tulpoida Say, l. c., i. p. 160. Dekay, op. cit., p. 18, pl. vii. f. 17. Smith, U. S. Fish Comm., p. 548, pl. ii. f. 5. Ibid., Trans. Conn. Acad., iii. p. 311.

In the Union College collection appear specimens from the beach of Chesapeake Bay opposite Fort Monroe, Beaufort, N. C., Sarasota Bay, Fla. Specimens from the first locality measure 26 mm. in length of carapax. Mr. Miers has made a mistake in quoting Prof. Gibbs, as this species does not occur at Boston except in collections.

Cape Cod to Florida (Smith), Venezuela (Miers), Cuba and Mexico (Guerin), Rio Janerio (Dura, Heller, Miers), Corinto, West Coast Nicaragua! (McNiel). These specimens are certainly *H. emerita*, and not *H. analoga*, Stm.

FAMILY ALBUNEIDÆ.

Genus **ALBUNEA** Fabr., Stm.

Albunea paretii Guerin.

Albunea paretii Guerin, Revue et Magazin de Zoologie, II. v. p. 48, pl. i. f. 10.

Albunea oxyophthalma Leach (MS.), White, List Crust. Brit. Museum, p. 57 (sine descr., teste Miers). Miers, Journ. Linn. Soc., xiv. p. 329, pl. v. f. 14-15.

A single specimen from Sarasota Bay agrees with Mr. Miers's description and figures, except that the median emargination is less deep and the lateral portion of the front more advanced and more curved, the eyes also appear to be rather more slender. It agrees well with Guerin's short description, and, as his was the first published description, his name will of course hold. Miers gives as localities St. Christophers, Cayenne, and Brazil. Guerin was not certain of the locality of his specimens, they were either

from Genoa or America. His types do not exist in the collection of the Philadelphia Academy.

Genus **LEPIDOPS** Stm.

Lepidops venusta Stm.

Lepidops venusta Stm., Proc. Phila. Acad., 1858, p. 230. Ibid., Ann. Lyc., vii. p. 79. Miers, Journ. Linn. Soc., xlv. p. 332.

A single specimen, which I refer without a doubt to this species, was dug up on the beach near Fort Macon, N. C. It agrees well with Stimpson's description, and certainly is not *L. scutellata*, from which it differs in the shape of the eyes, the form of the front, the dactyli of the second pair of feet, etc. Stimpson's type was from St. Thomas.

PAGURIOIDEA.

Professor Webster collected a large number of specimens belonging to this sub-order, but I am unable to report on them.

THALASSINOIDEA.

FAMILY GEBIDÆ.

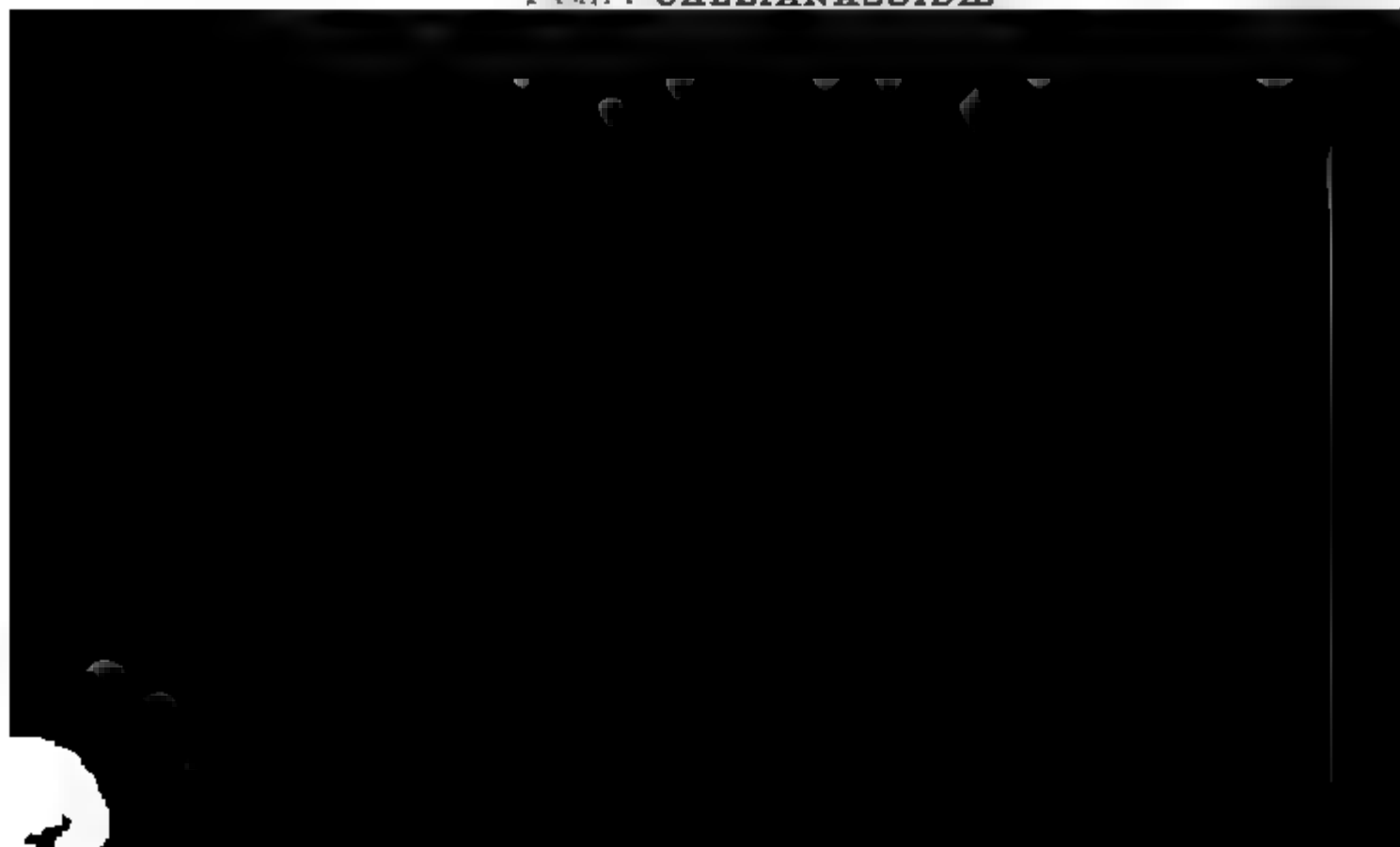
Genus **GEBIA**.

Gebia affinis Say

Gebia affinis Say, l. c., l. p. 241. Smith, Fish Comm., p. 549, pl. ii. f. 7.

Specimens were collected at Beaufort, N. C., and Sarasota Bay, Fla. Long Island Sound to South Carolina (Smith), Charleston, S. C. (Gibbes).

FAMILY CALLIANASSIDÆ



A single specimen was collected at Plantation Key, Fla., Antilles (Edw.), Key West (Gibbes), Isthmus of Panama (Streets).

I give below a revision of the genera of *Caridea* belonging to the families *Crangonidæ*, *Atyidæ*, and *Palæmonidæ*. It is founded on the arrangement of Dana. The genera of which I have seen specimens I have designated by the letter "o." As I have recently published a synonymical list of the North American Shrimps (Bulletin Essex Institute, x. pp. 53-71, 1878), I have refrained in most cases from giving the synonymy of the species collected by Prof. Webster.

CARIDEA.

Body generally laterally compressed, the carapax not united to the epistome, usually a broad lamelliform appendage (antennal scale) on the basal joint of the antennæ, sometimes, however, it is wanting; antennulæ bi- or tri-flagellate; mandibles varying in form, sometimes with, sometimes without a palpus; external maxillipeds generally pediform; feet generally long and slender; gills composed of lamellæ, five to eight pairs; abdomen long, the sides produced downwards.

FAMILY CRANGONIDÆ.

Mandibles slender, incurved, cutting edge narrow, not dilate or bifid, without a palpus, first and second pairs of feet unequal.

Sub-Family Crangoninæ.

First pair of feet stouter than the second. Hand sub-chelate, the dactylus closing on the margin of the palm, the pollex being spiniform. External maxillipeds pediform.

o Genus CRANGON Fabr.¹ Rostrum very short, eyes free, antennulæ biflagellate, first pair of pereopoda stout, but little longer than the second, second pair slender, elongate, chelate, remaining pairs acuminate. Branchiæ five on each side. Type *Crangon vulgaris* Fabr.

Crangon vulgaris Fabr. Several specimens were collected at Northampton Co., Va.

¹ Including *Steiracrangon* Kinahan, Proc. Royal Irish Acad., viii. p. 68 (1863).

o Genus *PONTOPHILUS* Leach, Sars.¹ Rostrum short, eyes free; antennulæ biflagellate; first pair of pereopoda stout, second pair very short, slender, chelate. Branchiæ seven, including a rudimentary one on the second maxillipeds. Type *Pontophilus spinosus* Leach.

o Genus *SABINEA* Owen.² Rostrum very short, eyes free, stout; second pair of pereopoda very short, not chelate, dactylus minute. Branchiæ as in *Pontophilus*.

o Genus *NECTOCRANGON* Brandt.³ Rostrum wanting; eyes nearly hidden by the carapax; second pair of pereopoda chelate; dactyli of fourth and fifth pairs dilated, natatorial. Branchiæ five on each side, none on the second maxilliped. Type *Nectocrangon lar* (Owen sp.).

o Genus *PARACRANGON* Dana.⁴ Rostrum elongate, eyes free; second pair of pereopoda obsolete, fourth and fifth pairs acuminate gressorial. Type *Paracrangon echinatus* Dana.

Sub-Family *Lysmatinae*.

First pair of pereopoda stouter than the second, both pairs chelate, fingers subequal, carpus of the second pair annulate. External maxillipeds pediform.

o Genus *NIKA* Risso.⁵ Rostrum short, antennulæ biflagellate. Hands of first pair of pereopoda dissimilar, one being chelate, the other not; carpus of second pair elongate, multiarticulate; hand minutely chelate. Type *Nika edulis* Risso.

o Genus *LYSMATA* Risso.⁶ Rostrum elongate, sub-ensiform, dentate; antennulæ triflagellate; first pair of pereopoda stout

nath; first four pairs of feet with exopodite; first pair rather stout, chelate, second filiform chelate, carpus multiarticulate. Type *Hippolysmata villata* Stm.

Hippolysmata wurdemanni (Gibbes, sp.) Stm. Professor Webster collected a large number of this species at Sarasota and Florida Bays, Fla. There also occur in the collection some young specimens from Bird Shoal, Beaufort, N. C., which I doubtfully refer to this species. I have seen specimens from Fort Jefferson (Lieut Jacques), and Key West (Packard).

o Genus *TOZEUMA* Stm.¹ Body greatly elongate, slender, compressed; rostrum slender, very long, sometimes scarcely shorter than the body; antennulæ short, biflagellate; external maxillipeds very short, without exognath or flagellum, pereopoda without palpi; first pair very short, stout, chelate, second filiform, chelate; carpus triarticulate, telson elongate, lanceolate. Type *Tozeuma lanceolatum* Stm.

Tozeuma carolinensis Kingsley (Plate xiv. fig. 8), was collected at Charlotte Harbor, Fla., and Beaufort, N. C.; at the latter place in a surface net.

o Genus *LATREUTES* Stm.² Carapax with a dorsal median spine. Rostrum elongate, lamellate, antennulæ biflagellate, basal scale short, orbiculate, hidden under the eyes; antennal scale acute; external maxillipeds short, with exognath; first four pairs of pereopoda with palpi, first two pairs chelate, second with the carpus triarticulate. Type *Latreutes ensiferus* (Edw., sp.).

Genus *RHYNCHOCYCLUS* Stm.³ Rostrum large, lamellate, orbiculate, antennulæ biflagellate, peduncle short; external maxillipeds short, with exognath; first four pairs of pereopoda palpigerous; first two chelate, second with the carpus triarticulate. Type *Rhynchocyclus planirostris* (De Haan, sp.).

o Genus *CONCORDIA*,⁴ nov. Dorsum of carapax strongly protuberant; rostrum very short, eyes free; antennulæ with two very short flagella; antennal scale very small; flagellum moderate; external maxillipeds short, stout; first pair of pereopoda shorter

¹ Proc. Phila. Acad., 1860, p. 26. *Angasia* White, Sp. Bate Proc. Zool. Soc. London, 1863, p. 498.

² Proc. Phila. Acad., 1860, p. 27.

³ *Cyclorhynchus* De Haan, Fauna Japonica, Crustacea, p. 174 (nom. præoc.) *Rhynchocyclus* Stm., Proc. Phila. Acad., 1860, p. 27.

⁴ Named in honor of Union College, to which the specimens belong.

and stouter than the second pair, which in turn are shorter than the remaining pairs; the carpus two articulate. Type *Concordia gibberosus*, sp. n.

Concordia gibberosus, sp. n. (Plate xiv. fig. 5). Carapax with the dorsum strongly elevated, and armed with five spiniform teeth; the first of which is on the rostrum, the last at about the middle of the carapax; carapax between the teeth ecarinate; rostrum very short, not exceeding the short and stout eyes; antennulæ with two very short flagella, the outer swollen and ciliate; antennal scale extending slightly beyond the peduncle of the antennulæ; flagella short, small, regularly tapering, about twice the length of the carapax. First pair of pereopoda short, stout; fingers about as long as the palm, second pair longer and more slender; carpus two-jointed, first joint longer than the meros, and about twice as long as the second, remaining feet slender, elongate, the propodal joints with a few spines on the posterior margin; dactyli short, curved, with spines on the concave margin; abdomen strongly bent at the middle; telson narrow, tapering, sides straight, extremity acute.

A female with eggs from Fort Macon was about 8 mm. long.

Sub-Family Gnathophyllinæ.

Second pair of pereopoda larger than the first pair, external maxilliped broad, operculiform.

o Genus GNATHOPHYLLUM, Latr. Rostrum short, compressed, antennulæ with two very short flagella, carpus of the second pair of pereopoda not articulate.

lower portion, fingers with long pencils of hairs; third, fourth, and fifth pairs much larger and stouter. Type *Atya scabra* Leach.

o Genus *EVATYA* Smith.¹ Rostrum prominent, carinate, with spines above, anterior portion of carapax with scattered spines and spiny carinations. Third pair of pereopoda very stout and tuberculate, basis and coxa anchylosed, ischium and meros firmly united, propodus much shorter than carpus, dactylus very short, unguiform. Type *Evatya crassa* Smith.

o Genus *ATYOIDA* Randall.² Rostrum, antennæ, antennulæ, and the two anterior pairs of pereopoda as in *Atya*; third pair of pereopoda elongate, scarcely stronger than the two anterior pairs.

Known species:—

Type *A. bisulcata* Randall. l. c. p. 140. *Sandwich Islands*.

A. tahitensis Stm. Proc. Phila. Acad., 1860, p. 28. *Society Islands*.

A. mexicana Stm. Am. Journ. Sci. and Arts, II., xxvii. p. 446.

Caradina mexicana Saussure, op. cit., p. 45, pl. iv. f. 26, *Mexico*.

A. poeyi Guerin, in Raman de Sagra Hist. Cuba, *Cuba*.

A. glabra Kingsley. Proc. Phila. Acad., 1878, p. 93, *West Coast Nicaragua*.

o Genus *CARADINA* M. Edw. Rostrum moderate, antennulæ bi-flagellate; second pair of pereopoda longer than first, fingers of both pairs with pencils of hairs, carpus of first pair very short, excavate in front, of second pair oblong, subcylindrical. Type *Caradina typus* M. Edw.

Genus *ATYEPHYRA* Brito Capello.³ Rostrum many toothed, carapax with supraorbital and antennal spines; hands hairy, and resembling those of *Atya*; eyes well developed.³ Type *A. rosiana*.

Genus *TROGLOCARIS* Dormitzer.⁴ Rostrum thin, with fine teeth on the borders; supraorbital and antennal spines present; eyes rudimentary, pereopoda much as in *Caradina*. Type *Troglocaris schmidtii* Dorm.

¹ Second and third Reports Peabody Academy of Science, p. 95 (1871).

² Journ. Phila. Acad., viii. p. 140 (1839). According to E. von Martens (*Archiv für Naturgeschichte*, xxxiv. pl. i. p. 47, 1868), this is not a valid genus, as the young of *Atya* have the third pair of pereopoda as in *Atyoida*.

³ Discr. esp. nov. de Crustaceos de Portugal, p. 5, 1866.

⁴ Lotos, III. p. 85 (1853).

Sub-Family *Ephyrinae*.

Pereiopoda with an exopodite.

Genus *MIERSIA* Kingsley.¹ Rostrum toothed, antennulæ biflagellate, two anterior pairs of pereiopoda, chelate small; the carpus of the second pair not annulate; the three posterior pairs slender. Type *Miersia pelagica* (Risso sp.).

The known species are:—

pelagica (Risso sp.). *Mediterranean*.

punctulata (Risso sp.). *Mediterranean*.

compressa (De Haan sp.). *Japan*.

FAMILY *PALÆMONIDÆ*.

Mandibles stout, incurved, deeply bipartite, apical process narrow, oblong.

Sub-Family *Alpheinae*.

First pair of feet the larger, chelate; second slender, filiform, generally chelate, carpus frequently annulate.

Section I. MANDIBLES WITH A PALPUS.

o Genus *ALPHEUS* Fabr.² Rostrum very short or wanting, antennulæ biflagellate, eyes hidden under the carapax; mandibles with a two-jointed palpus; external maxillipeds slender, moderate; first pair of pereiopoda generally greatly differing in size; carpus of second pair annulate. Type *Alpheus rapax* Fabricius.

Alpheus minus Say. Numerous specimens were collected. The

about twice as long as the last joint. Antennal scale narrow, regularly tapering, lamellar portion not extending to the spine terminating the external margin. External maxillipeds elongate, extending beyond the antennal peduncle, the last joint with a long pencil of hairs. Larger hand inflated, the upper outer proximal portion circumscribed by an impressed line, a slight constriction of the margins near the articulation of the dactylus; thumb short, with a shallow groove on the outer surface, which extends a short distance on the palmar portion. Dactylus contorted, extending beyond the thumb, extremity rounded. The dactylus and distal portions of the propodus punctate and setose, especially on the inner surface. Smaller hand subcylindrical, fingers about as long as palm, gaping, tips acute, margins fringed. Carpus of second pair five-jointed, first joint three times, and second twice as long as the third or fourth, which are subequal and slightly shorter than the fifth. The telson regularly tapering, the extremity sinuate-truncate. The exopodite of the sixth pair of pleopoda (abdominal feet) bears on the external distal angle of the penultimate joint, an articulated conical black spine, the color persisting in alcohol, and which will readily separate this from any species with which I am acquainted. Its affinities are with *A. sulcatus* of Panama and Peru.

Three specimens from Key West, the largest 25 mm. in length.

Alpheus heterochelis Say. Specimens were collected at Sarasota Bay, Charlotte Harbor, Marcou Pass, Harbor Key, and at Northampton County, Virginia, Eastern Shore, Atlantic side; this last being the farthest north from which the species has been reported.

Alpheus packardii, sp. n. Front, antennulæ and antennæ as in *A. heterochelis* except that the sulci between the base of the rostrum, and the ocular hoods are deeper, and last joint of antennular peduncle longer than in that species. External maxillipeds short, not reaching to the tip of antennal scale. Chelipeds unequal, meros with an acute tooth on the upper distal angle; larger hand strongly compressed, with a sharp tooth above near the articulation of the dactylus, beyond this the hand becomes narrower by means of a sharp bend of the inferior margin, dactylus contorted, and working at an angle of about 30° with the plane of the hand. Smaller hand more slender, but similarly ornamented and armed, the dactylus, however, being spatulate, working vertically, and with its margins and those of the opposing thumb densely fringed with hairs. Car-

pus of the second pair with the first two joints equal, and each as long as the third and fourth together, which, in turn, are subequal, and each slightly shorter than the fifth joint. This species, in a systematic arrangement of the North American forms, would stand between *A. heterochelis* and *A. transversodactylus*, but more nearly to the former. The differences from that species are not easy to describe, but are well marked in the specimens.

I have dedicated this species to my friend and former instructor, Dr. Alpheus S. Packard, Jr., not only as a token of esteem, but also from a recognition of the appropriateness of the name. Three males from Key West. Length, 22 mm.

Alpheus candei Guerin in de Sagra's *Historia de Cuba Crustaceis* (p. L. pl. ii. f. 9). *Alpheus transversodactylus* Kingsley. Two specimens were taken at Key West.

Besides these species of *Alpheus* there is a single specimen approaching *A. candei* most nearly in form, but differing from that species in form of front, and in having a large swollen pyriform hand without grooves, etc., which I hesitate to describe as new.

o Genus *ALOPE* White.¹ Rostrum short, toothed above, and placed in a groove formed by two spines which arise at the anterior portion of the carapax, and extend nearly as far as the rostrum. Eyes but little salient, antennulæ biflagellate; external maxilliped very long; hands of first pair of pereopoda equal; carpus of second pair annulate. Type *Alope palpalis* White.

Genus *ARETE* Stimpson.² Rostrum short, rounded above; eyes free, antennulæ biflagellate; antennal scales larger. External maxillipeds slender, moderate; hands of first pair of pereopoda

ensiform, not articulated to the carapax; antennulæ biflagellate; external maxillipeds slender; first pair of feet short, equal; second pair slender; carpus multiarticulate. Type *Hippolyte spinus* (Sowerby sp.).

Genus CARIDION Göes.¹ Rostrum elongate, cultrate; mandibles with a three-jointed palpus: antennulæ biflagellate; first two pairs pereopoda nearly equal, chelate, carpus of the first pair very short; of the second elongate, obsoletely biarticulate. Type *Caridion gordonii* (Spence Bate sp.).

Genus BYTHOCARIS G. O. Sars.² Rostrum very small, simple, unarmed; antennulæ biflagellate; antennal scale large and broad; external maxilliped with the last joint dilated, obliquely truncate, and armed with teeth, a minute exognath present. First pair of feet as in *Hippolyte*; second pair slender, weak; carpus multiarticulate. Type *Bythocaris simplicirostris* G. O. Sars.

Genus CRYPTOCELES G. O. Sars.³ Rostrum small, narrow, toothed above; antennulæ biflagellate; antennal scale large, externally dentate; last joint of external maxillipeds with the apex somewhat bipartite, a small exognath present. First pair of pereopoda very short; hand very elongate and attenuate, digits very short, and with difficulty visible; second pair slender; carpus 7-jointed. Type *Cryptocheles pygmæa* G. O. Sars.

o Genus RHYNCHOCINETES M. Edw. Resembling *Hippolyte*. Rostrum ensiform, movable, articulated to the carapax; antennulæ biflagellate; carpus of second pair of pereopoda not jointed. Type *Rhynchocinetes typus* M. Edw.

o Genus OXYRIS Stm.⁴ Carapax not rostrate, or with rostrum very small, as in the genus *Alpheus*. Eyes very long; antennulæ

in the Archiv für Naturgeschichte, 1846, pt. 2, p. 310-311, says that there are no points mentioned by Costa which would not apply to *Hippolyte*. On the other hand Heller (Crustaceen des südlichen Europa, p. 256, 1863) regards one of Da Costa's species (*P. elegans*) as belonging to the genus *Anchistia* of Dana. For remarks on the synonymy of *Hippolyte* and that of *Virbius*, attention is called to Smith, Trans. Conn. Acad. v. pp. 62 and 63, 1879.

¹ Ælversigt af K. Vetensk. Akad. Förhandl. 1863, p. 170. *Doryphorus* Norman, Ann. et Mag. Nat. Hist. 3d series, viii. p. 276, 1861 (nom. præoc.).

² G. O. Sars, Særskilt aftrykt af Vidensk. Selsk. Forhandlingar, p. 5, 1869.

³ Vidensk. Selsk. Forhandlingar, p. 150, 1868.

⁴ Stimpson, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 36.

biflagellate, the peduncle with a spine joint; antennal scale shorter than antenna; with a two-jointed palpus; external maxilla exognath; pereopoda without epipodite; second pair triarticulate. Type *Ogyris*.

Ogyris alphærostris, sp. n. (Plate xiv.) without dorsal carina; rostrum very slender, being one of that of *Alpheus*. Eyes reniform, elongate, slender, half as long as the antenna, slightly beyond the antennal peduncles, larger than the ocular peduncle. Antenna on outer surface of the basal joint; biflagellate about as long as the peduncle. Antenna narrow, lanceolate, reaching nearly to the tip of the peduncle; flagella three times as long as the peduncle and one-half times the length of the carapace; long, stout, the distal joint being very slender; long hairs, exopodite slender. First pair chelate; meros, carpus, and hand nearly equal in length to the palm. Second pair very slender; carpus triarticulate, hand similar to that of the first pair; fourth pairs subequal, slender; the dactylus being not over one-third the width of the carpus; pair very slender, more so than any of the others; ischium longer than the meros, which in the three last joints; carpus, propodus. The three last pairs of pereopoda have

count of its habitat; the other species, *O. orientalis* Stm., coming from China and Japan.

Genus PTEROCARIS Heller.¹ Carapax and abdominal segments broadly expanded at the sides. These expansions lamellate and three-lobed, corresponding one to the antennal segments, one to the mandibular, and the third to the abdominal segments. Eyes small, just visible in front of carapax; antennulæ biflagellate; antennæ with basal scale; external maxillipeds with exopodite and rudimentary epipodite. Type *P. typica* Heller.

Section II. MANDIBLES WITHOUT A PALPUS.

Genus AUTONOMEA Risso.² Rostrum short, eyes prominent, antennulæ biflagellate, antennal scale wanting. First pair of pereopoda stout, chelate; second not chelate; carpus not annulate. Type *Autonomea olivii*.

o **Genus VIRBIUS Stimpson**³ Dorsum of carapax and rostrum ecarinate; antennulæ biflagellate; antennal scale present. External maxillipeds short, with exopodite. Pereiopoda without epipodites. Carpus of first pair of pereiopoda excavate in front; carpus of the second pair triarticulate. Type *Virbius acuminatus* (Dana sp.).

o **Sub-genus THOR Kingsley.**⁴ Rostrum short; antennulæ, antennæ, and external maxillipeds as in *Virbius*. Carpus of first pair of pereiopoda not excavate; carpus of second pair 5-articulate. Type *Thor floridanus* Kingsley.

Thor floridanus Kingsley. (Pl. xiv. fig. 6.) Specimens were collected by Professor H. E. Webster at Harbor Key and Sarasota Bay, Florida.

¹ Sitzungsberichte der k. Akad. Wissenschaft. Wien. XLV. pt. i. p. 395, pl. i. f. 7-18 (1862).

² I take the fact that the mandible of *Autonomea* is without a palpus from Heller (Crust. Südlichen Europa, p. 223), though in his generic diagnosis on p. 249 he makes no mention of the mandible, but takes his description from Desmarest. Heller had never seen specimens of this genus. Risso (Crust. Nice, pp. 166-169, 1816) does not mention the mandibles.

³ Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 85. For remarks on this genus, vid. Smith, Trans. Conn. Acad. v. p. 62, 1879. *Caradina tenuirostris* Spence Bate, Proc. Zool. Soc'y, London, 1863, p. 501, pl. xl. f. 4, from Australia, belongs to this genus.

⁴ Proc. Acad. Nat. Sci. Philadelphia, 1878, p. 94.

Sub-Family *Pandalinae*.

Antennulae biflagellate, mandibles with a palpus, anterior pereopoda very slender, not chelate; second filiform chelate; carpus multiarticulate.

o Genus *PANDALUS* Leach.¹ Type *Pandalus montagui* Leach.

Sub Family *Palæmoninae*.

Two anterior pairs of pereopoda chelate; carpus of none annulate; second pair larger than the first, pereopoda without palpi.

Section I. MANDIBLES WITHOUT A PALPUS.

A. Antennulae biflagellate.

Genus *TYPTON* Costa.² Rostrum small, eyes free, antennal scale absent, external maxillipeds pediform, with exognath. Type *Typton spongiola* Costa.

o Genus *PONTONIA* Latreille. Rostrum short, eyes prominent, antennulae with the outer flagellum bifid at the extremity; antennal scale moderate. External maxillipeds suboperculiform with exognath; second joint broad, longer than remaining joints together, these last cylindrical. Type *Pontonia custos* (Forsk. sp.) Guérin. *Pontonia tyrrhena* (Risso sp.) Latreille.

Pontonia unidens, sp. n. (Pl. xiv. f. 9.) Carapax pubescent, depressed; rostrum short, acute, slightly depressed, not extending as far forward as the eyes; orbital spine present though small;

duncle. First pair of pereiopoda slender, longer than the carapax; meros, carpus, and hand nearly equal, the fingers half as long as the palm. Second pair of feet unequal; larger hand inflated, longer than the carapax, pubescent; fingers one-third the length of the palm, incurved and slightly depressed; the dactylus with a large obtuse tooth near the base, which fits into a corresponding cavity in the pollex (as in many species of *Alpheus*); pollex without teeth. Smaller hand three-fourths as long as the larger, cylindrical straight fingers one-third as long as the palm. Remaining pereiopoda moderate, minutely unguiculate. Telson about twice as long as broad, sides strongly arcuate.

Key West, Fla., A. S. Packard, Jr.

Length 10 mm.

This species differs from *P. domestica* Gibbes in the pubescence of the carapax and hands, and in having but one tooth on the dactylus of the larger hand of the second pair and none on the thumb, etc. etc. It may prove to be the *Pontonia mexicana* of Guérin-Meneville in Ramen de la Sagra's *Historia física, política y natural de la Isla de Cuba*, 1856. The types are in the Museum of the Peabody Academy of Science at Salem, Mass. None were collected by Prof. Webster.

Genus CORALLIOCARIS Stm.¹ Rostrum small; eyes large and prominent; antennal scale very broad; external maxillipeds operculiform; all the joints of nearly equal width; second pair of pereiopoda large, long, subequal; dactyli of posterior pairs with a protuberance on the under side near the base. Type *Coralliocaris superbus* Dana, sp.

Genus HARPILIUS Dana.² Closely allied to *Pontonia*, but differing in having the distal joints of the external maxillipeds together longer than the second joint; second pair of pereiopoda long, slender, equal. Type *Harpilius lutescens* Dana.

o Genus ANCHISTIA Dana.³ Rostrum long, slender, frequently ensiform; eyes prominent; antennulæ with one flagellum partly bifid; external maxillipeds slender, pediform; second pair of pe-

¹ Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 38. *Ædipus* Dana, U. S. Ex. Ex. Crust., p. 572, 1851 (nom. præoc.).

² Op. cit., p. 574, 1851.

³ Op. cit., p. 577 (1851), *Pelias* Roux, *Memoire sur le Salicoques*, p. 25 (1881). Heller, *Sitzungsber. der K. Akad. Wiss. Wien*, xlv. pt. 1, p. 406 (1863), non Merrian (1820).

mens collected by Prof. Webster at Beaufort, N. C., Marcou Pass, and Charlotte Harbor, Fla. Only four specimens were obtained, two male and two female.

Rostrum compressed, not reaching the extremity of the antennular peduncles; above arcuate, with seven or eight teeth, the second of which is directly above the insertion of the eyes; antennal scale large, extending beyond the antennular peduncle, the sides parallel, the extremity obliquely rounded, truncate; first pair of pereopoda reaching the tip of the antennal scale, the second longer, the fingers of each about as long as the palm, remaining feet bi-unguiculate, all very slender and almost filiform; abdomen between four and five times the length of the carapax; third segment (and sometimes the fourth also) of the abdomen swollen, fifth short, sixth about the length of the carapax; telson slender, elongate, sides straight, regularly tapering to the acute tip. The female appears to be rather stouter than the male. Length 15.5–20 mm.

Section II. MANDIBLES WITH A PALPUS.

A. Antennulæ biflagellate.

Genus *PALÆMONELLA* Dana.¹ Body not depressed; rostrum moderate; eyes of medium size; mandibular palpus two-jointed, very short; antennulæ biflagellate, one flagellum with the apex bifid; external maxillipeds slender, pediform. Type *Palemonella tenuipes* Dana.

o Genus *HYMENOCERA* Latreille. Antennulæ biflagellate, one flagellum membranous, dilated, and foliaceous; first pair of pereopoda very slender, hand minute, second stouter, very broad, hand and dactylus membranous.

B. Antennulæ triflagellate.

o Genus *PALÆMON* Fabr.² Rostrum lamellate, dentate; eyes free; mandibles with a three-jointed palpus; external maxillipeds slender. Type *Palæmon squilla* (Linne, sp.).

¹ U. S. Expl. Exped. Crust., p. 582.

² *Leander*, Desmarest, Annales Société Entomologique de France, vii. p. 87, 1849. *Bithynia*, Philippi, Archiv für Naturgeschichte, xxvi. pt. 1, pp. 161–164 (1860). *Macrobrachium*, Spence Bate, Proc. Zool. Soc'y London, 1868, p. 363.

Genus *CRYPHIOPS* Dana.¹ Rostrum of medium size; eyes wholly hidden under the carapax, as in *Alpheus*; external maxillipeds slender. Type *Cryphiops spinulosimanus* Dana.

Sub-Family **Oplophorinae.**

First pair of pereopoda either didactyle or vergiform, second stouter, chelate; antennulae biflagellate.

Genus *OPLOPHORUS* M. Edw. Rostrum long, dentate, pereopoda all palpigerous; four anterior chelate; antennal scale with the external margin spined; abdomen armed above with one or more long spiniform processes. Type *Oplophorus typus* M. Edw.

Genus *CAULURUS* Stm.² Rostrum long or short; basal scale of antennulae wanting; basal scale of antennae externally unarmed; external maxillipeds pediform, with exognath; pereopoda furnished with exopodite, the first two pairs chelate, the second pair slender and long; dorsum of abdomen unarmed; sixth abdominal segment long and slender. Type *Caulurus pelagicus* Stm.

As there is nothing except the length of the rostrum to separate *Xiphocaris* from *Caulurus*, I have thought best to unite them. *Xiphocaris* has but a single species, *Hippolyte elongata* Guerin = *Oplophorus Americanus* Saussure.

Genus *THALASSIOCARIS* Stm.³ Rostrum and antennulae as in *Oplophorus*. Feet not palpigerous, anterior pair not chelate; second pair stout, chelate; mandibular palpus triarticulate; third segment of abdomen prolonged into a long spine above. Type *Thalassiocaris lucidus* (Dana, sp.).

Sicyonia carinata M. Edw., Hist. Nat. Crust., ii. p. 410. Dana, U. S. Ex. Crust., p. 602. Smith, Trans. Conn. Acad., ii. p. 40. Von Martens, Archiv für Naturgesch. xxxviii. p. 143.

Of this species, which is reported from Rio Janeiro by Edwards and Dana, and from Cuba by von Martens, two specimens were collected by Prof. Webster, one at Sarasota Bay and the other at Charlotte Harbor.

Genus *PENEUS* Fabr.

Peneus constrictus Stm. A single specimen was collected at Marcon Pass.

Peneus braziliensis Latreille. From Beaufort, N. C., Marcon Pass, Charlotte Harbor, and Sarasota Bay, Fla. I would here say that the specimens described by me as *Peneus brevirostris* (Proc. Acad. Nat. Sci. Philadelphia, 1878, from the west coast of Nicaragua, prove to be *P. braziliensis*, thus adding another to the list of species common to both coasts.

In my "List of Decapod Crustacea of the Atlantic Coast, whose range embraces Fort Macon" (Proceedings Philadelphia Academy, 1878, pp 316-330), I enumerated sixty-five species, of which fifty-three had at that time been reported from Fort Macon. In this paper six more of these species are reported from there, while *Polyonyx macrocheles*, *Lepidops venusta*, *Hippolydmata wurdemannii*, and *Concordia gibberosa*, which were not enumerated in my list, were found there by Prof. Webster, and *Ogyris alphe-rostris*, from its near locality, may reasonably be expected there.

EXPLANATION OF PLATE.

Fig. 1. *Mithraculus hirsutipes*; 1a. Antennal region.

Fig. 2. *Pisosoma glabra*.

Fig. 3. *Eupalamus websteri*; 3a. External maxilliped.

Fig. 4. *Euceramus prælongus*; 4a. External maxilliped. 4b. Telson.

Fig. 5. *Concordia gibberosa*.

Fig. 6. *Thor floridanus*; 6a. Antennula. 6b. Mandible.

Fig. 7. *Ogyris alphe-rostris*.

Fig. 8. *Tozeuma carolinensis*.

Fig. 9. *Pontonia unidens*; larger hand outside; 9a. Ditto inside.

DECEMBER 2.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-six persons present.

DECEMBER 9.

The President, Dr. RUSCHENBERGER, in the chair.

Fifty persons present.

A paper entitled "Description of a Foetal Walrus," by Harrison Allen, M.D., was presented for publication.

Complete Connection of the Fissura Centralis (Fiss. of Rolando) with the Fossa Sylvii.—Dr. A. J. PARKER stated that Dr. Chas. K. Mills had lately observed, while examining the brain of a white person, that the central fissure ran completely into the fossa Sylvii without any bridging convolution being found present. The fissura centralis, as it exists in the higher primates, begins at the upper border of the hemisphere, and extends obliquely downwards and forwards, terminating above the Sylvian, so that we find an arched convolution surrounding its lower end and completely separating it from the Sylvian fissure. In 1866, however, Turner reported a case (Edinburgh Medical Journal, 1866) in which he found this fissure joining the Sylvian. This appears to be, up to that time, the only recorded case. Ecker, in speaking of this observation (Cerebral Convolutions of Man, trans. by R. T. Edes, M.D., 1873), says: "I have not yet seen a complete opening of

complicated arches." The primary fissures, according to him, are the anterior and posterior branches of the fossa Sylvii; the fissura centralis or fissure of Rolando, fissura perpendicularis interna or parieto-occipital fissure, fissura parallela or superior temporal fissure, and the fissura hippocampi. This latter fissure of Bischoff corresponds to Gratiolet's fissure des hippocampes, and includes both the fissura hippocampi and the fissura calcarina of other writers. The type is expressed, according to Bischoff, by these fissures, and the development of the convolutions consists merely of arched windings surrounding the ends of these primary furrows, and the further development of the convolutions arises in fact through the stronger development, bending backwards and forwards, rising and sinking of the lobules around the above-named furrows. Through this process there arise secondary folds and fissures, side convolutions and connections and separations of individual convolutions. The same, says Bischoff, may be different on the two sides of the same brain and in different individuals, the ground forms being, therefore, more or less hidden, but we can recognize them easily in all brains. He hopes, however, that it will soon be possible to explain and make intelligible these individual modifications. There are, however, convolutions which, as Bischoff remarks, do not appear to be in unison with this type, such as the first and second frontal and the convolutions of the occipital and temporal lobes. For these Bischoff says that he can find no particular plan on which they may be based. They arise one after the other, and become more and more complex, as it appears, from purely mechanical necessities of the surface increasing in a definite space. In this manner arise the first and second frontal fissures, the second temporal, fissura collateralis, etc., and their bordering convolutions. Thus, in the frontal lobe, Bischoff points out two upper frontal convolutions, and a third or inferior arching around the ascending branch of the fossa Sylvii. In the frontal lobe an anterior and a posterior central winding arching around the upper and lower extremities of the fissura centralis. Posterior to these, at the upper border of the hemisphere and extending over on to the mesial surface, a superior internal parietal group of convolutions (obere innere Scheitelgruppe) corresponding to the lobulus parietalis superior and præcuneus. Besides these, Bischoff points out five so-called arched parietal convolutions. A first or anterior parietal arched convolution (erste oder vordere Scheitelbogenwindung) surrounding the upper extremity of the horizontal branch of the fossa Sylvii. A second or middle (zweite oder mittlere Scheitelbogenwindung) surrounding the upper extremity of the superior temporal fissure. Posterior to these a third smaller arched convolution which curves around the upper end of the fissura temporalis media, the dritte Scheitelbogenwindung. He admits, indeed, that the arrangement of these arched convolutions is very variable and manifold, and therefore the

appearance of these arches is not always easily discerned. He also distinguishes a superior internal (obere innere oder vierte Scheitelbogenwindung) surrounding the upper extremity of the fissura perpendicularis interna. This corresponds with the pli de passage supérieur externe, Gratiolet, gyrus occipitalis primus, Ecker; oberer Zug der hintern Centralwindung (in part), Huschke; erste obere Hinterlappenwindung, Wagner, first external annectent gyrus, Huxley; first bridging annectent or connecting gyrus, Turner. An inferior internal (untere innere oder fünfte, Scheitelbogenwindung) surrounding the lower extremity of the fissura perpendicularis interna. This corresponds with the pli de passage interne inférieur of Gratiolet; gyrus cunei of Ecker. The existence of a pli de passage interne supérieur is not admitted by Bischoff, who considers that this convolution is homologous with the pli de passage supérieur externe. Ecker dissents from this view of the case, and the speaker had attempted to show in a previous communication (Plis de passage in the Primates, Proc Acad. Nat. Sciences, Philadelphia, 1878) that at least in certain cases Bischoff is correct. In the occipital lobe Bischoff distinguishes three convolution groups, an outer upper, the so-called cunus, and two lower, an internal superior (lobulus lingualis), and an external inferior (lobulus fusiformis). In the temporal lobe Bischoff does not differ in his divisions from previous writers.

The observations referred to at the beginning of this communication in reference to the union of the central and Sylvian fissures is not in accordance with the views of Bischoff, at least in the absolute manner in which he proposes them; and that he considers the presence of these arching convolutions around the ends of the primary furrows as absolutely essential, is shown by his criticism of Turner's observation referred to above, and also of Dr. Rolleston's observations on the premier pli de passage. In seven human brains examined by Dr. Rolleston in reference to the de-

DECEMBER 16.

The President, Dr. RUSCHENBERGER, in the chair.

Fifty-seven persons present.

DECEMBER 23.

The President, Dr. RUSCHENBERGER, in the chair.

Seventy-two persons present.

DECEMBER 30.

The President, Dr. RUSCHENBERGER, in the chair.

One hundred and ninety persons present.


The following reports were read and referred to the Publication Committee :—

REPORT OF THE PRESIDENT FOR THE YEAR ENDING NOVEMBER 30, 1879.

The history of the Academy for the year ending Nov. 30, 1879, is not very remarkable. It may be briefly stated.

The Academy offered, Feb. 1879, to receive on deposit the collections made by the second geological survey of the State of Pennsylvania; and asked the Legislature to appropriate money towards enlargement of the building for the purpose of affording ample space for the display of a distinct collection of specimens illustrative of all departments of the natural history of Pennsylvania, including those of the geological surveys. It is believed that a separate museum of the kind proposed would be attractive and interesting to visitors generally, as well as instructive. It would ultimately become an objective representation of all the natural resources of the State, and possibly suggestive of new applications of them in the industrial arts, and at the same time tend to enhance in public estimation the value of the study of the natural sciences.

All the members of the Legislature were invited to visit the institution in the evening of April 25th. Several of those who were present at this reception expressed opinions favorable to



which reasons for the appeal are stated. Several subscriptions have been received and promised, making an aggregate of about \$3000, or about one-twentieth of the amount considered to be necessary.

The financial condition of the Academy is fully stated in the report of the Treasurer.

Two young men have been recipients of the benefits of the Jessup Fund, one during the entire year, and the other for nine months. The application of this fund has been so beneficent in the past as to suggest that additional scholarships or fellowships of the same kind would contribute largely to the general progress of the natural sciences in this community.

The extent of increase of the museum and of the library, and their condition, are stated in the annual reports of the curators and the librarian.

The annual reports of the several sections of the Academy indicate that they are active and prosperous.

The Biological and Microscopical section gave a public reception on the first Monday of April, and a second on the first Monday of November. The Entomological section participated in the last. It is estimated that more than two thousand ladies and gentlemen were present at each reception, and all seemed pleased. Receptions of the kind are believed to be advantageous to the general interests of the Society.

The average attendance at the meetings has been 32; the most numerous, Feb. 4, 109, and the least, July 15 and August 26, 14.

Although well known to the few old members still living, it may be well on this occasion to recall part of the old story of the foundation of the Academy.

All the founders and early members were not at the time masters, or even advanced students, in any department of natural history. They were, generally speaking, young men whose livelihood depended upon the profits of their daily avocations—men who, though possibly not qualified to be professors, were learned enough to discern that they might lessen their own ignorance of natural things by employing their leisure together, in a joint way to learn what others already knew, and possibly add something to the common stock of knowledge.

The first formal meeting for organization, January 25, 1812, is recorded as a "meeting of gentlemen, friends of science and of

French book of essays, which was discussed at the
proceedings imply that mutual improvement was
of the association.

For the reason that the founders and first
themselves to be learners they called their So
meaning a school, the word being derived ac
graphers from *Azadhetas*, the name of an Athe
house was converted into a school in which Ph

The general policy of the organization in
securing "the greatest good to the greatest num
should cheerfully and sincerely co-operate to p
of the Society according to the ascertained view
March 21, 1812, the Society consisted of the
the minutes of the meeting of that day they s
faithful and honorable to each other, and zealot
of science, such an establishment as we desir
place."

The qualifications for membership were frien
and good moral reputation and nothing more.
didates are not required to possess any ot
Membership of this Academy does not, nor w
to, imply any kind or degree of scientific att
than membership of a building association in
skill in any department of construction or hous

There are societies whose certificate of membe
estimation at the same time a certificate of scie

equally entitled, subject only to such restrictions as were considered necessary for their preservation.

From the formation of the society to the present time, its policy has been based on such principles, and to those principles it owes much of its substantial prosperity and present condition.

Original research was not the sole object of the society, nor was it ever designed that the society should be composed exclusively of masters in science, specialists, or experts. Members worthy to be so entitled are most desired and honored, most beneficial to the Society, and most deserving to be aided in all reasonable ways, in the use of its accumulated means and facilities of study, not in conflict with the rights which are alike and equally common to all members, learned and unlearned. No part of the museum or library can be held in reserve for the exclusive use of any class of specialists.

The purposes of the Academy are, and always have been :—

1st. To aid and encourage those who may labor to increase knowledge of natural objects, and of the laws under which they exist.

2d. To encourage and aid novitiates in natural science.

3d. To diffuse knowledge resulting from original researches, among the votaries of natural science everywhere.

4th. To render knowledge of the natural sciences generally attractive and interesting to the public.

The purpose first named, to encourage original investigations, is manifest in the free access to the museum and library, given to specialists who may desire to use those sources of information in their studies, and in the publication of the results of their labors when desired. This sort of encouragement is not restricted to members of the society. Publishing discoveries made elsewhere, or by others than members of the Society, is no discredit to the liberality of the Academy, and is surely not calculated to impede original research.

The purpose placed second, to encourage and aid novitiates, is realized by instructing them individually, and pointing out to them approved methods of study in order that they may become qualified to engage profitably in original investigations. The many beneficiaries of the Jessup Fund bear witness to the beneficent influences of the Academy under this head. They compensate the institution for the benefits it confers by the work they

it under the direction of the curators, and by becoming on auspices practical, working naturalists.

The importance of this purpose lies in the fact that in training and elementary instruction are indispensable attainment of the highest grades of learning.

The third named purpose, to diffuse knowledge, is carried by publishing a Journal, and the Proceedings of the Academy. The Journal now consists of eight octavo and seven quarto volumes: the fourth part of the eighth volume is in preparation. The "Proceedings of the Academy" numbers thirty-one volumes. During the year 385 pages have been printed.

The entomological section of the Academy has published during the year, more than two hundred pages of original matter, arising from the researches of members of the section and their printing has been done by members of the section in the hall of the Academy.

It is proper to mention in this connection, "The Natural History of the Agricultural Ant of Texas," a monograph on the habits and architecture of *Pogonomyrmex barbatus*, by Christopher McCook, a member of the society, which has been issued with the imprint and under the auspices of the Academy. It is an octavo volume of 310 pages, illustrated by 24 plates.

Also the "Manual of Conchology, Structural and Systematic, with illustrations of the species," by George W. Tryon, J. D. Servator of the conchological section of the Academy, published by the author, and issued from the Academy. The first part has appeared during the year. It is an octavo volume

by Dr. Charles Pickering, was published at Boston, in May, 1879. It is a quarto volume of 1222 pages. The work is conspicuous on account of the immense erudition and industry displayed by the author. It will ever stand an enduring monument significant of the respect due to his memory.

This volume is mentioned here because Dr. Pickering was a diligent student in the Academy, and served it efficiently and very constantly during eleven years, from the early part of 1827 till the middle of 1838. His studies in this Academy contributed largely to qualify him to deserve the very high position he attained in the scientific world.

Gratuitous labor has produced all the matter published by the Academy and its entomological section ; and probably the authors of the volumes named have little hope of pecuniary profit from their work.

The fourth named purpose : to render knowledge of the natural sciences attractive and interesting.

During many years the students of all medical colleges in the city have been freely admitted to the museum on exhibiting their matriculating tickets to the janitor. Annual complimentary tickets have been issued to the teachers of the public schools, who are authorized to bring with them at each visit, a limited number of their pupils. The museum is accessible to all persons every day except Sunday, on the payment of an admission fee of ten cents. The amount received on this account indicates that the museum has been visited by 3540 persons besides members and those introduced by them.

Summaries of the proceedings of the Academy are published in the newspapers. They are supposed to be generally interesting.

In the ways indicated the several purposes of the institution are carried out, it is believed, with considerable success.

The sections afford opportunity to those having like pursuits and congenial tastes to work together, and are useful in their influence on the general interests of the society. It is not perceived that they are in any way detrimental to scientific progress.

The by-law of May, 1876, which authorizes the appointment of professors is inoperative, because the endowments for their support, which were hoped for at the time, have not been made, and because candidates have not applied for the positions.

In spite of the lack of professors, the Academy is reasonably

prosperous. It is free from debt. It has a substantial home as land enough upon which to extend it. It has a large and excellent library adapted to its purposes, and large collections of natural objects, many of which have not been studied. It is conjectured that the library and museum cannot be duplicated at the time by the expenditure of half a million of dollars.

Among its members are some who are conspicuous for attainments, and for the discoveries they have made; many who are skilful specialists, and very many more who are availing themselves so diligently of the facilities which the Academy affords that there is ground to hope that when those who are now held in the highest estimation shall have passed away, their places will be filled by men as great or even greater than they are now believed to be.

Notwithstanding the general character of its membership, and the unpretentious methods and policy which it has followed in the past, there are associated with the Academy some among those who have died, whose names are widely known and respected on account of the positions they attained in science. We may name for examples, Charles L. Bonaparte, John Cassin, Edward H. Lowell, Wm. M. Gabb, Richard Harlan, Charles A. Leseur, James Aitken Meigs, Samuel George Morton, Thomas Nuttall, George Ord, Charles Pickering, Thomas Say, and Gerard Troost; and others might be added who in their day were worthy and respected on account of their attainments, and their contributions to scientific progress.

There is no substantial reason to mourn now on account of the

The names of nineteen members and three correspondents who have died during the year, have been recorded in the Proceedings under the date of announcement.

Twenty-two papers have been presented for publication, as follows: John A. Ryder, 4; H. C. Chapman, 3; Angelo Heilprin, 3; J. B. Ellis, 2; J. S. Kingsley, 2; Andrew Garrett, 2; W. N. Lockington, 2; Wm. G. Binney, 1; Dr. H. Bergh, of Copenhagen, 1; Edw. D. Cope, 1; Chas. Wachsmuth, and Frank Springer, 1. The Publication Committee has reported in favor of the publication of all these in the Proceedings.

One hundred and ninety-four pages of the Proceedings for 1878 and one hundred and ninety-one pages of the volume for 1879 have been printed during the year. The current volume will be illustrated by seventeen plates.

Verbal communications have been made by Messrs. Leidy, Meehan, Ford, Ryder, Koenig, Kelly, Ashburner, Potts, Horn, Evarts, Chapman, McCook, Kenderdine, A. J. Parker, Goldsmith, Hunt, Martindale, Canby, Rothrock, Warder, Porter, Foote, Cope, Pierce, Willcox, Dercum, Redfield, Barbeck, Brinton.

At the meeting held March 25th, Prof. Edw. D. Cope was elected to fill a vacancy in the Council caused by the death of Dr. J. H. McQuillen.

EDW. J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

The Corresponding Secretary presents herewith the report of matters pertaining to his office during the year ending Nov. 30.

There have been eight Correspondents elected by the Academy, all of whom have been notified.

The correspondence received during the year has been, for the most part, that transmitting the publications of corresponding societies or other organizations, and from Correspondents acknowledging their election. Those letters requiring an answer have received proper attention.

The letters written have been in great part acknowledgments of donations to the Museum. These letters, numbering 177, cover a much greater number of donations.

Respectfully submitted,

GEO. H. HORN, M.D.,
Corresponding Secretary.

lets having been added to the entries made last year. The catalogues of the books on helminthology, ichthyology, and herpetology have also been finished, leaving only those on anthropology and mineralogy to be yet entered. In addition to the books catalogued, there are in the library a large number of literary, artistic, and historical works to which I have before called attention for the purpose of recommending that they be sold, and the funds applied to the purchase of books more specially useful to the society. In the hope that this disposition may be made of these works, it is not the intention at present to extend the card entries to these departments, so that the catalogue will probably be completed early next year.

Constant effort has been made to complete, as far as possible, the sets of periodicals in the library, and to add those not yet in the possession of the Academy. This work will be materially forwarded by the issue of Mr. Scudder's invaluable Catalogue of Scientific Serials, which furnishes a means not before at hand of determining our deficiencies.

For the amounts expended on the purchase of books reference is made to the report of the Treasurer. The accompanying list of additions made during the year indicates, as heretofore, that for the most valuable items, apart from our exchanges, we are dependent upon the I. V. Williamson Fund.

All of which is respectfully submitted,

EDW. J. NOLAN,
Librarian.

REPORT OF THE CURATORS.

The Curators report that during the year all the various collections of the Museum have been carefully inspected and cared for, and that they are all in good condition. A violent storm, which caused considerable destruction of glass and flooding of rain, wetted some parts of the collections, but the objects were speedily dried, so that little serious damage resulted, except the loss of several specimens of echinoderms. Mr. J. A. Ryder has been continuously engaged in identifying, arranging, and labeling the collection of fishes. There have been identified upwards of 700 species of 325 genera. The Bonaparte collection of fishes, considering the time it has been preserved, is in addition.

Mr. Spencer Trotter has also been engaged in the arrangement of the birds.

The collection of vertebrate fossils from the New Jersey cretaceous and tertiary marls, which are very liable to decomposition from exposure to the air, have been treated so as to preserve them, and they have been arranged and labeled.

Most of the specimens received during the year have been placed in their proper positions in the various collections.

The most important addition to the Museum during the year, consists of the Archæological collection belonging to the American Philosophical Society, deposited with the Academy by resolution of Nov. 16, 1877. The collection mainly consists of the Poinsett collection of Mexican antiquities and many Peruvian and other American antiquities. The Academy is indebted to Mr. William S. Vaux, for defraying the expense of adapting one of the entresol rooms to the proper exhibition of the collection.

The contributions in the various departments during the year, excepting those reported on by some of the special sections, are as follow:—

Mammals.—Five skeletons: *Tapirus indicus*, *Auchenia*, *Dicotyles*, *Sus*, and *Phascolomys*, presented by Dr. H. C. Chapman. Seal caught off Marcus Hook, Levi Cromwell. Skeleton of a native of the Chatham Islands, W. H. Rau. Young Chimpanzee, Phila. Zool. Society. Red Fox, Harford Co., Md., I. C. Martindale. Monstrous new-born Sheep, W. H. Faulkner.

ciety. *Orthagoriscus mola*, Atlantic City, N. J., J. L. Howard. *Lophius americanus*, Atlantic City, N. J., S. D. Button. Embryo of Ray, Dr. H. C. Evarts.

Articulates.—*Artemia fertilis*, *Limnadia compleximanus*, *Streptocephalus watsoni*, and *Branchinectes coloradensis*, presented by Dr. A. S. Packard. *Streptocephalus sealii*, Woodbury, N. J., W. P. Seal. *Chirocephalus holmani*, Woodbury, N. J., Messrs. Seal and Holman. *Palinurus vulgaris*, Medt., John Ford. *Eubbranchipus vernalis*, Long Island, F. Gissler. Two crustacean parasites and two worms, from *Orthagoriscus*, J. L. Howard. *Polyxenes fasciculatus*, Fairmount, J. A. Ryder. *Mygale hentzii*, *Buthus*, *Mantis*, *Cryptoglossa verrucosa*, *Eleodes armata*, *Scelopendra*, Ft. Yuma, Cal., Dr. Joseph K. Corson, U. S. A. *Lucanus elephas*, Swedesboro, N. J., Richard French. *Platylepas decorata*, Hernando Co., Fla., Jos. Willcox. Nests of the Honey Ant, *Myrmecocystis*, Colorado, Rev. H. C. McCook. Three insects mounted in soluble glass, and cocoons and raw silk of the silk-worm, Dr. S. Chamberlain.

Radiates and Protozoans.—A small collection from Mt. Desert, Me., presented by Dr. H. C. Chapman. *Sertularia argentea*, Boring-sponge in the shell of the oyster; *Pterogorgia setosa*, W. I., and *Doricidaris papillata*, Medt., John Ford. *Penella pilosa*, with attached *Conchoderma*, J. L. Howard. *Spongilla lacustris* and *Pectinatella magnifica*, Woodbury, N. J., W. P. Seal. *Cristatella idae*, Fairmount, Dr. Jos. Leidy.

Fossils.—Fossil fishes, and bones of *Uintatherium*, *Palæosyops*, and Crocodile, Green R., Wyoming, presented by Dr. H. C. Chapman. Fragments of jaws with molars of *Rangifer caribou*, from the loess of Muscatine, Iowa, Prof. F. M. Witter. Foot-prints of *Anthracopus ellangowensis*, Ellangowan Colliery, Mahanoy, Pa., W. D. H. Mason, through W. Lorenz. Bones of Gavial, miocene, N. J., and two coal fossils, *Lepidostrobus*, Carbondale, Pa., Dr. Jos. Leidy. Tooth of *Carcharodon megalodon*, picked up on the shore of Atlantic City, N. J., E. Lippincott. Fragment of bone, Vincenttown marl, N. J., Col. T. M. Bryan. Trilobite, T. A. Conrad. *Maclurea*, carboniferous limestone, Upton, Franklin Co., Pa., Annie Ryder. Casts of skull and jaw of *Acotherulum saturninum*, Phosphate beds of Jersey, Prof. Paul Gervais. Ramus of lower jaw and portion of tibia of *Mastodon andium*, S. A., deposited by Dr. I. C. Coates. Tooth of *Mosasaurus*, Chalk of

Meudon, France, *Leucociscus papyraceus*, *Protomyia macrocephala*, and *Micropsalis papyracea*, miocene of Rott, near Bonn, purchased.

Ethnological and Miscellaneous.—Necklace with ornament, two carved gourd vessels, bows and arrows, blow-gun, spears, from Costa Rica and California, collected by the late Wm. M. Gabb, together with a portrait of the latter, presented by Mrs. C. G. Gabb. Fire-stick of Digger Indians, Sacramento R., Cal., W. C. Desmond. Indian stone-pipe, Bedford Co., Pa., E. Draper. Cloth made from Yucca fibre, Mexico, Dr. C. C. Parry. Fragments of steatite vessels from an ancient steatite quarry, Rock Creek, near Washington, D. C., W. J. Rhees. Stone mortar, East Tennessee, A. D. Trimble. Stone implement, Hernando Co., Fla., Jos. Willcox. Copper bracelet, Thebes, C. F. Parker. Stone carving, Cave Temple of Elephanta, and sandals of the Arabs of Muscat, Dr. Ruschenberger. Five stone axes, Pa.; three ditto, N. J.; one ditto, with terra-cotta pot and bowl from a mound, New Madrid, Mo.; stone scrapers and chips, Wyoming Ty., in exchange, from Dr. Leidy.

Respectfully submitted by the Curators,
JOSEPH LEIDY, *Chairman.*

REPORT OF BIOLOGICAL AND MICROSCOPICAL SECTION.

<i>Auditors</i>	. . . . .	Dr. George Dixon, Charles P. Perot, S. Fisher Corlies,
<i>Committee of Curators</i>	.	Dr. J. Gibbons Hunt, Charles Zentmayer, Jacob Binder,
<i>Committee on Business</i>	.	Charles P. Perot, Charles Zentmayer, Dr. Charles Turnbull.

ROBT. J. HESS,
Recorder.

REPORT OF THE CONCHOLOGICAL SECTION.

The Recorder of the Conchological Section respectfully reports that during 1879 papers have been accepted and published in the Academy's Proceedings aggregating 90 pages, by authors as follows:—

W. G. Binney, 1 page.	Angelo Heilprin, 6 pages.
Andrew Garrett, 14 pages.	R. E. C. Stearns, 7 pages.
Dr. R. Bergh, 62 pages.	

On the 6th of last January the Section met with a severe loss in the death of the Rev. E. R. Beadle.

From its formation to the time of his death Dr. Beadle was the secretary of the Conchological Section, and his ability and extended acquaintance among scientists both at home and abroad went far towards making it a success. His loss will be deeply felt by many who, in common with ourselves, have been richly benefited by his acquaintance and influence.

The Conservator, Mr. George W. Tryon, Jr., reports that, during the year ending December 1, 2750 trays, containing 11,895 specimens of shells and mollusks, have been determined, labelled, mounted, and placed in the collection. The most of these belong to the Swift Collection, the arrangement of which, after three years' labor, is now completed. The Swift Cabinet was given to the Academy upon condition that it should not be incorporated with the general collection, and this condition is complied with by placing the specimens in drawers protected by glass tops, and

placed under the corresponding genera contained in the table cases. It is proposed to appropriately letter the fronts of these drawers, and then unlock them so that they may be opened by the public. The Swift Collection is rich in West Indian shells, and particularly so in terrestrial species: it comprises 7058 trays, containing 30,384 specimens. Mr. W. G. Binney has frequently favored us with specimens of rare American terrestrial mollusks during the year, so as to nearly complete our series of these shells. Dr. W. D. Hartman, of Westchester, who is preparing for publication a revision of the Partulidæ, has carefully examined our collection of these perplexing shells, and added a number of species. We are indebted to Dr. J. J. Brown for a good collection of marine shells from the Bahama Islands, and to Mr. Henry Vendryes for a fine series of Jamaica Miocene shells. A typical suite of the land shells collected by the late Wm. M. Gabb in Costa Rica is among the important additions to our Museum during the year. A detailed list of donations is annexed to this report.

The Section is again greatly indebted to Mr. Charles F. Parker for valuable assistance in preparing specimens for exhibition, the whole of the additions to the cabinet during the year having been mounted on tablets, and placed on appropriate paper trays by him. We are also much indebted to Mr. John Ford for preparing sections of shells for the purpose of showing their internal form. It is proposed to exhibit a section of a characteristic form in each genus, and Mr. Ford has kindly undertaken to prepare them

The following are the additions to the Conchological Cabinet received during 1879:—

Binney, Wm. G. *Bythinia tentaculata*, from Champlain Canal, W. Troy, New York; *Unio heterodon*, Mixville, Conn.; *Sphærium rhomboideum*, *Helix Rugeli*, and *H. Andrewsii*, Roan Mt., N. C.; *H. globulus*, *H. vernicosa*, and *H. rari-plicata*, Cape Town, S. Africa; *H. oppilata* and *H. Buffoniana*, Mexico; 20 species N. Am. Helices, new to the collection; *Bulimus Natalensis*, Cape Town; *Urocyclus* and *Veronicella*, from Mozambique; *Simpulopsis corrugatus* and jaws and tongues of *Ampullaria urceus*, Trinidad; *Vittrina latissima*, *Onchidella Carpenteri*.

Bland, Thomas. 3 species of land shells from Curaçoa; 7 species marine shells from the tertiary of Jamaica.

Brown, Dr. J. J. 60 species marine shells, mostly collected by him at the Bahama Islands.

Calkins, W. W. *Cylindrella Guigonana*, Haiti.

De Tarr and Beecher. *Planorbis costatus*, types.

Fisher, Dr. Jas. L. (Nagasaki). *Soletellina Buddinghausii*, Japan.

Ford, John. Beautifully prepared sections of *Nautilus Pompilius*, and of 32 prosobranchiate Gasteropod shells; *Helix tridentata*, *H. alternata*, and *H. albolabris*, from 'Three Sisters' Islands, Niagara Falls; *Crepidula fornicata*, *C. unguiformis*, *Anomia ephippium*, Sandy Hook, N. J.

Gabb, Wm. M. 43 species (numerous specimens) terrestrial and fluviatile shells, principally types of species recently described by Messrs. G. F. Angas and W. G. Binney. Collected by Mr. Gabb in Costa Rica.

Hartman, Dr. W. D. *Partula recta* and *bicolor*; 16 species (49 specimens) of *Partula*; *Unio* from Japan, and *Cardium*, nov. sp. from Viti Isles.

Jones, Dr. W. H. Mollusks dredged by him at Havre, France, etc.

Lea, Dr. Isaac. *Unio Irwinensis* and *U. differtus*, Lea.

Lewis, Dr. James. *Bythinia tentaculata*, Oswego, New York.

Leidy, Dr. Joseph. *Mactra solidissima*, abnormal growth, Brigantine Beach, N. J.

Mactier, W. L. *Lacuna divaricata*, Nantucket.

Mickleborough, John. A collection of Silurian fossil shells from the Cincinnati Group, Cincinnati, Ohio.

Munroe, Prof. C. E. 5 species of Eocene shells, from Maryland.

- Peale, Titian R. *Limax maximus*, New York City.
- Pike, Prof. J. W. Silurian shells, from Richmond, Ind.
- Shaffer, Miss M. *Loligo Pealei*, from a black fish caught in Delaware Bay.
- Stearns, R. E. C. 12 species land and marine shells, from California and Japan.
- Stein, Frederick. *Goniobasis papillosa*, from Florida.
- Tryon, Geo. W., Jr. 137 species of terrestrial mollusks (of which 70 are new to the collection), collected by Andrew Garrett in the islands of Central Polynesia
- Vendryes, Henry. Kingston, Jamaica. A typical collection of 88 species of Miocene shells, from the island of Jamaica.
- Webb, H. W. 18 specimens (55 species) of terrestrial mollusks, from Balsas, Valley of Marañon, Peru.

REPORT OF THE ENTOMOLOGICAL SECTION.

The Section reports that its meetings have been regularly held during the past year on the second Friday evening of each month excepting in July and August. In December the meeting takes place immediately after that of the American Entomological Society on the second Wednesday evening.

The membership is now thirty, having been increased during the year by the admission of Geo. B. Cresson.

The average attendance at the meetings has been six.

At all of the meetings scientific communications have been

United States," "Synopsis of the Nitidulidæ of the United States," "Notes on the Mycteridæ and other Heteromera of the United States," by George H. Horn, M.D.

The foregoing have been published as part of the Transactions of the American Entomological Society, and together with papers published during December of last year, amount to one hundred and seventy-three pages with one plate.

In addition to the above the following papers have been accepted for publication, and will form part of Volume VIII. of the Transactions: "Descriptions of new species of North American Hymenoptera," "Catalogue of North American Tenthredinidæ and Uroceridæ," by E. T. Cresson; "Notes on the Asaphes of Boreal America," "Revision of the Dascyllidæ of the United States," "Contributions to the Coleopterology of the United States," by George H. Horn, M.D.; "Short Studies on North American Coleoptera," by J. L. LeConte, M.D.

With the beginning of the year the Section has published the "Proceedings of the monthly meetings of the Entomological Section of the Academy of Natural Sciences," in which are contained a record of the doings of the Section with the shorter papers and verbal communications from the members, and a list of all publications received in exchange, by purchase or from the authors.

The total publications excluding Index are—

Transactions of the American Entomological Society	. 173 pp.
Proceedings of the Section	. . . . . 34 pp.
	<hr/>
Giving a total of	207 pp.

By the invitation of the Biological and Microscopical Section, the Entomological Section joined with them on the occasion of their last reception in the endeavor to make the resources of the Academy more widely known, and the exhibition more varied and entertaining to those who favored us with a visit. The crowded rooms and the interest shown by our visitors spoke well not only for the grand microscopical display, but also for our more modest exhibit.

During the year the collections have been carefully examined several times thoroughly by the Conservator and by the members while using them. They are reported in good order. Very few additions have been made.

At the annual meeting in December, the following officers were elected to serve during 1880:—

<i>Director</i>	.	.	.	.	John L. Leconte, M.D.
<i>Vice-Director</i>	.	.	.	.	Geo. H. Horn, M.D.
<i>Recorder</i>	.	.	.	.	Jas. H. Ridings.
<i>Treasurer</i>	.	.	.	.	E. T. Cresson.
<i>Conservator</i>	.	.	.	.	Geo. B. Cresson.
<i>Publication Committee</i>	.	.	.	.	Geo. H. Horn, M.D., Samuel Lewis, M.D.

All of which is respectfully submitted,

Geo. H. HORN, M.D., *Vice-Director,*
for the Recorder.

REPORT OF THE BOTANICAL SECTION.

The Vice-Director of the Botanical Section has much pleasure in reporting to the Academy the satisfactory progress it has made during the past year. The Section now consists of thirty-five members, and the meetings held every month, except August and September, have been well attended. At these meetings many new and valuable facts in relation to our local flora, as well as to the science of Botany in general, have been contributed by many of the members. Of the papers read before the meetings one by Mr. Ellis, of Newfield, New Jersey, and one by Professor Asa Gray, have been of such general importance as to receive the re-

The work of revising the various families so as to bring the nomenclature in accord with modern views, and which in former reports it was believed could scarcely be accomplished without the employment of experts to be especially engaged for the purpose, still remains to be done—but the voluntary labors of several distinguished botanists have aided us the past year to a good beginning for even this herculean task, and we may hope that it will not be very long before the whole is treated in the same way.

It is no derogation to the assistance we have received from many members and friends to say that much of the excellent progress made is due to the energy of our Conservator Mr. John H. Redfield, whose report in detail has been adopted by the Section as part of this report.

THOMAS MEEHAN,
Vice-Director.

The Conservator reports that the work of the past year has been mainly directed to the improvement of the condition of the Academy's valuable Herbarium, and this labor has been interrupted only by the necessary care and attention bestowed upon the constant new accessions to its stores.

The order-tablets and genus lists for the North American Herbarium have been completed.

Mr. Isaac C. Martindale has carefully elaborated and catalogued the species of Clematis, Anemone, and one or two other allied genera, both in the general and in the North American departments, a tedious and difficult labor which has revealed both the extent and the weaknesses of our collection. Mr. Charles F. Parker has also neatly mounted these species, and the work of these two gentlemen, while only the beginning of a gigantic task, is a model for future workers.

Dr. Asa Gray, of Cambridge, has during the year revised for us some of the most perplexing of the genera of the North American Compositæ, such as Vernonia, Solidago, Chrysopsis, etc., and Mr. Parker is securing to us the result of this labor, by mounting the plants (with Dr. Gray's notes affixed) as fast as elaborated.

Mr. Bebb, who, in 1878, worked out for us the willows of our North American Herbarium, has this year performed a similar service upon those of the general Herbarium, with infinite addition to their scientific value.

Mr. F. L. Scribner has continued his careful and scrutinizing work upon our grasses, mounting them as he progresses, and we may expect an early completion of so much of the work as relates to the North American Herbarium.

The Conservator has mounted and ticketed that portion of the North American Herbarium which extends from the Order Goodeniaceæ to Order Gentianaceæ inclusive, and hopes to continue the work.

The accessions to our collection have been constant, extensive, and valuable. The number of species received during the year has been 2181, of which a good proportion were new to our shelves. All these have been carefully poisoned, labeled, mounted, and distributed in the proper orders. Mr. C. F. Parker has been of most essential service in this work, giving us many hours of labor over and above his engagements with the Academy.

Among the valuable additions of the year may be specially mentioned 623 species of Florida plants, embracing many new and rare species, collected by Dr. A. P. Garber, of Columbia, Pa., and by him generously presented to the Academy; and many hundreds of rare plants from Northern and Central Asia, Northern, Southern, and Central Africa, Borneo, Kerguelen Land, Polynesia, California, Oregon, etc., presented by Dr. Asa Gray, of Cambridge, Mass.

A complete list of the donations during the year is appended to the report now respectfully submitted.

JOHN H. REDFIELD,

Conservator

Dr. Asa Gray; 60 species plants, collected by Hooker and Ball in Marocco in 1871; 22 species from Southern Europe; 55 species of Carices from Sweden and Lapland, and 3 species North American plants.

Dr. A. P. Garber, Columbia, Pa.; 555 species of plants collected by him mostly near Manatee, Florida.

John H. Redfield; 102 species European plants, mostly from Buda-Pesth, Hungary; also *Asplenium mucronatum*, from Tijuca, Brazil.

Thomas Meehan; *Viola Beckwithii*, collected in Washington Territory, by Mrs. F. E. Putnam.

Dr. J. A. Warder, Cincinnati, O.; sections of wood of *Catalpa bignonioides*, variety *speciosa*.

May. Dr. Asa Gray; 49 species plants, collected in Kerguelan Land, by J. H. Kidder, of British Transit Expedition, and 73 species collected mostly in Northern Borneo, by F. W. Burbridge.

John H. Redfield; 29 species of plants, collected by Dr. C. C. Parry and Dr. E. Palmer, chiefly in the region of San Luis Potosi, Mexico, in 1878.

Dr. C. C. Parry, of Davenport, Ia.; part of a saddle-cloth in common use in Mexico, made from the fibre of *Yucca*.

Wm. M. Canby; *Shortia galicifolia*, collected by M. E. Hyams, in McDowell Co., N. C.; also *Baptisia sulphurea*, from Limestone Gap, Indian Territory, collected by G. D. Butler.

Isaac C. Martindale; Ellis's 2d Century of North American Fungi, being 100 species of Fungi, neatly mounted in book form.

June. Miss E. S. Boyd; 37 species ferns from Sandwich Islands. George E. Davenport, Boston, Mass.; 5 species ferns, from Florida.

Wm. M. Canby; 2 species California ferns, new to the collection.

Ashmead Bros., Jacksonville, Fla., through Dr. G. H. Horn; *Sarracenia variolaris*, Mx., from Florida.

A. L. Siler, of Osmer, Utah; Cones of *Abies Engelmanni*, from Kanab Cañon, Southern Utah.

September. Dr. Asa Gray; 64 species plants, mostly from Oregon and California.

Nasalis	146	Persephone	408
Nasua	169	Petrolisthea	405
Natica	312	Phialocrinus	285, 347
Nebela	162	Phoma	68
Nectocrangon	412	Phorus	218
Neofelis	170	Physianthus	205
Neotoma	12	Pilumnus	396
Neptunus	398	Pinnixa	409
Nika	412	Pinnotheres	409
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The local collection has been arranged and labeled.

At the February meeting it was decided to admit, as associate members, persons interested in mineralogy but ineligible to active membership by reason of not being members of the Academy. Several such have been elected, and have attended the meetings and taken much interest in the proceedings.

Through the courtesy of the Biological and Microscopical Section, the Mineralogical Section has had the use of microscopes in the examination of sections of rocks, and of minerals included in others. Several interesting exhibitions of this character were had, showing an entertaining, and, as yet, little explored region, in which it is hoped the lady members of the Section may find a field peculiarly suited to their opportunities of study.

It is purposed to present to the Academy for publication a statement of the more important communications made to the Section.

The following list of additions made to the Mineralogical Cabinet during the year has been furnished by Mr. Chas. F. Parker:—

G. W. Baker. Nodules of Hematite, Venezuela.

A. J. Brand. Native Copper, Madison Co., W. Va.

Col. T. M. Bryan. Asphaltum, Amber, Flint and Geode of the same, probably pseudomorph of Sponge, from the marl of Vincenttown, N. J.

Dr. J. M. Cardeza. Fossiliferous(?) Sandstone, Del. Co., Pa.; Lignite, Elkton, Md.

Mrs. Hugh Davids. Stilpnomelane, Weilburg, Nassau; Braunite, Ilmenau, Thuringia; Ardenite, Salm-Chateau, Belgium; Berthierite in Quartz, near Freiberg, Saxony; Megabasite on Quartz, Bohemia.

John Ford. Tourmaline, W. side of Schuylkill, Phila.; Chlorite with Magnetite, above Manayunk: Pink Marble, Marble Hall, Mont. Co., Phila.

Mrs. Gabb. Borax, near Clear Lake, Cal.

G. N. P. Gale. Collection of minerals and rocks, Orange Co., N. Y.

J. Geismar. Gypsum, marl of Burlington Co., N. J.

E. Goldsmith. Peat, Nantucket Island, Mass.

J. M. Hartman. One hundred minerals from various localities, including a fine suite of Iron ores from Sweden.

Dr. H. Haupt, Jr. Stalactite, Giles Co., Va.

- Dr. F. V. Hayden. A fine collection of Geyserites, etc., Geysers of the Yellowstone National Park.
- W. W. Jefferis. Lignite, Penna. R. R. Tunnel, Baltimore, Md.; Bronzite, Bare Hills, Md.; Corundum and Culsageeite, Chester Co., and Kyanite, Lancaster Co., Pa.; Micaceous Iron, Lake Superior.
- Dr. Jos. Leidy. Steatite pseudomorph of Staurolite, Lisbon, N. H.; Apophyllite, Isle Haute, Bay of Fundy.
- H. C. Lewis. Native Sulphur, Surry Co., N. C.; Lignite, Kinkora, N. J.; Diatomaceous Earth, Richmond, Va.
- Dr. Linn. Muscovite with peculiar markings, Macon Co., N. C.
- W. L. Mactier. Amber, Nantucket, Mass.
- J. W. Peck. Calcite, from beneath a bed of upper Silurian Pentamerus, Delhi, Ind.
- Theo. D. Rand. Twelve Rocks, Mahanoy City, Pa.; Diabase, near Pottstown, Pa.; Euphyllite in Tourmaline, Pyrite, Quartz, xls., Chester Co.; Almandine, Dixon's Quarry, Delaware; forty-four Rocks, neighborhood of Phila.; Petroleum, Ennis-killen, Canada; Willemite, Franklin, N. J.; Drusy Quartz, Calcite, Montgomery Co., Pa.; Quartz, Andalusite, Delaware Co., Pa.; seventeen Rocks, Delaware Co., Pa.; Stalactite, Page Co., Va.; Molybdenite, Frankford, Phila.
- Dr. Ruschenberger. Obsidian, Mauna Loa, Hawaii, eruption of 1856.
- W. S. Vaux. Cuprite, Cornwall, England; Pyrosmalite, Nordmarken, Sweden; Gypsum, Monte Doneto, Bologna; four crystals of Orthoclase, Baveno, Lake Maggiore, Italy; Axi-

Louis, Mo.; Orthoclase, Gothite on Quartz, Orthoclase, Pike's Peak, Col.; Limonite, Neguancee, Mich.; Pyrolusite, Nova Scotia; Stalactite, Stalagmite.

Minerals purchased. Adamite on Quartz, France; Gersdorffite, Styria; Eudyalite and Arfvedsonite with Feldspar, Greenland; Wavellite, Montgomery Co., Ark.; Corundum and Lesleyite, Corundum, Barnhardtite, N. C.; Langite, Cornwall, England; Euxenite, Arendal, Norway; Helvite with Quartz and Zincblende, Saxony; Melilite in Lava, Humite, Vesuvius; Senarmontite, Algeria; Bytownite, Canada; Fergusonite in Quartz, with black Mica, Ytterby, Sweden; Sepiolite, Bonitz; Covellite, Dillenberg; Glaucodot, Sweden.

Minerals deposited by Am. Phil. Soc. Red Porphyry, Sweden; Pipe-stone, Sioux Country; Leopardite, N. C.; Zinc, the first manufactured in America, made from ore from Perkiomen Mine, Montgomery Co., Pa.

The collection of minerals of the Franklin Institute, and the rocks of the Rogers Survey of Penna., heretofore in its custody, have been deposited, on condition of their return on demand.

I would also report the completion of the numbering of the minerals in the Museum, in accordance with the catalogue, and the preparation of an alphabetical index of the same.

All of which is respectfully submitted,

THEO. D. RAND,

Director.

The election of Officers for 1880 was held, with the following result :—

<i>President</i>	.	.	.	W. S. W. Ruschenberger, M.D.
<i>Vice-Presidents</i>	.	.	.	Wm. S. Vaux, Thomas Meehan.
<i>Recording Secretary</i>	.	.	.	Edward J. Nolan, M.D.
<i>Corresponding Secretary</i>	.	.	.	Geo. H. Horn, M.D.
<i>Treasurer</i>	.	.	.	Wm. C. Henszey.
<i>Librarian</i>	.	.	.	Edward J. Nolan, M.D.
<i>Curators</i>	.	.	.	Joseph Leidy, M.D., William S. Vaux, Charles F. Parker, R. S. Kenderdine, M.D.

<i>Councillors to serve three years</i>	Rev. H. C. McCook, Edw. Potts, Isaac C. Martindale, Theo. D. Rand.
<i>Finance Committee</i>	Edw. S. Whelen, Clarence S. Bement, Aubrey H. Smith, S. Fisher Corlies, Geo. Y. Shoemaker.

ELECTIONS DURING 1879.

MEMBERS.

January 28.—H. Dumont Wagner, Charles Henry Hart, Jacob Binder, Geo. A. Binder.

March 25.—Joseph Mellors, Wm. S. Auchincloss.

April 29.—Robert Meade Smith, M.D., J. J. Kirkbride, M.D., Jas. F. Magee, Wm. S. Magee, Henry C. Coates, Henry W. Stelwagon, M.D., Robert S. Davis.

May 27.—Chas. Pennypacker.

June 24.—William P. Foulke.

July 29.—John M. Taylor, M.D.

October 28.—Russell S. Hill.

November 25.—John C. Dawson, H. Russell Bassler, Mrs. Mariné J. Chase, Benjamin Sharp, Otto Luthy, John Wilson.

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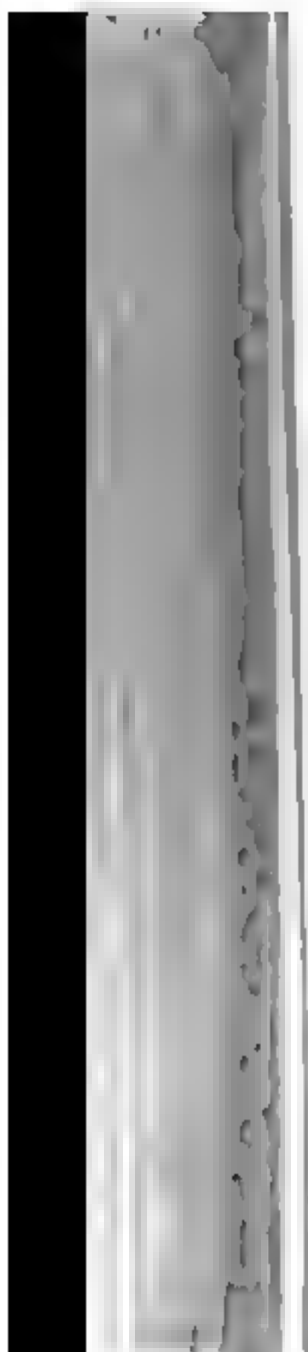
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Sur l'Amylogenèse dans le regne végétal The Author.
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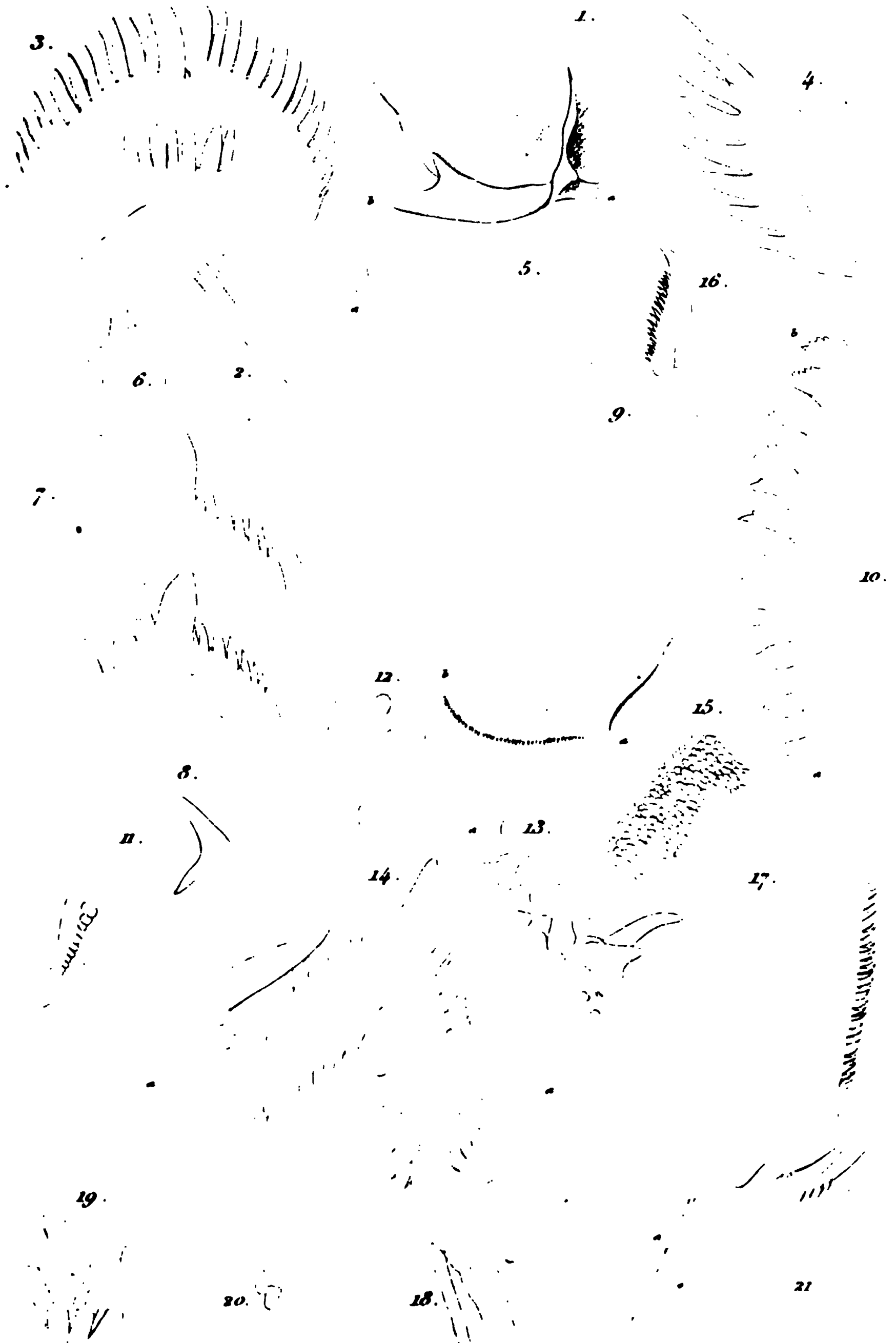
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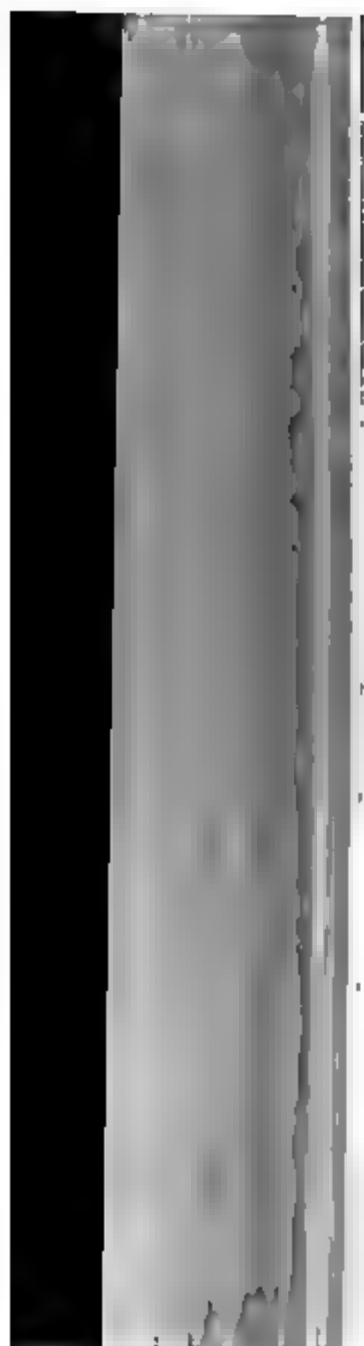
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1-6. *Acotidia papillosa* (L.) var. *pacifica*.
 8. *Hona marina* (Forsk.).
 1. *Hermisenda opalaceus* (Cooper).
 21 D. J.

13-14. *Coryphella* sp.
Flabellina iodinea Cooper
Aron purpureus Bq.

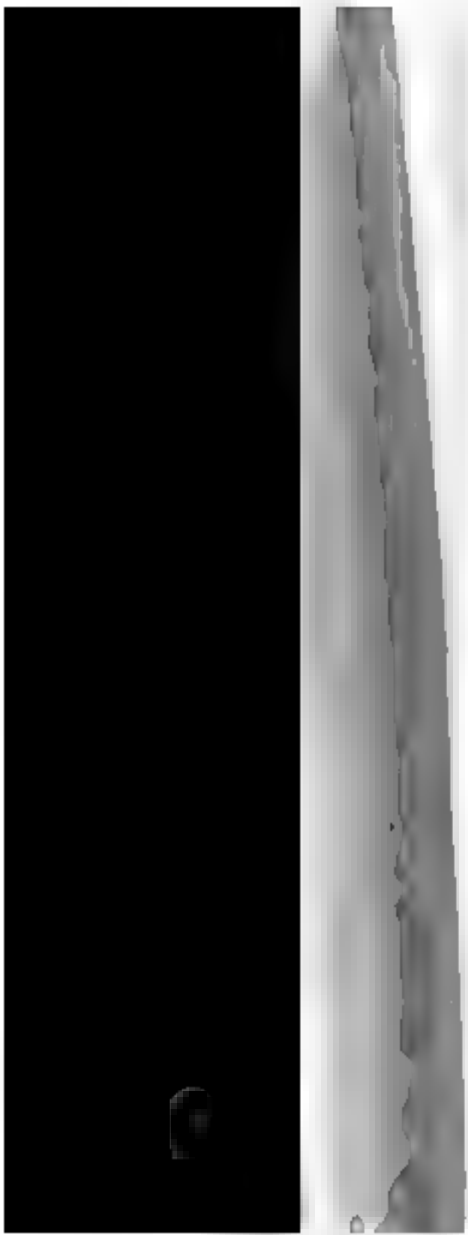




1-6. *Hermisenda opalescens* (Cooper).
 8. *Coryphella* sp.

9-12. *Pedronotus Palli*, Bgh.
 13-15. *D. arborescens* F.

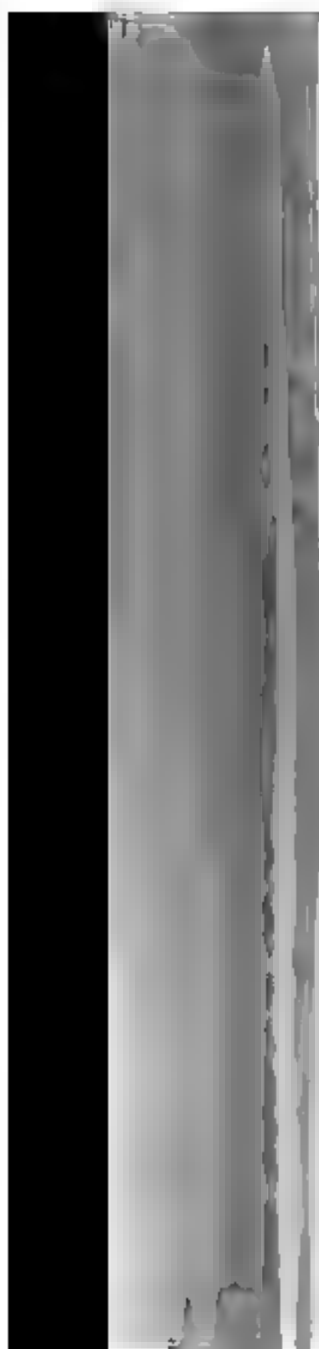
16. *Flab iodinea* C.

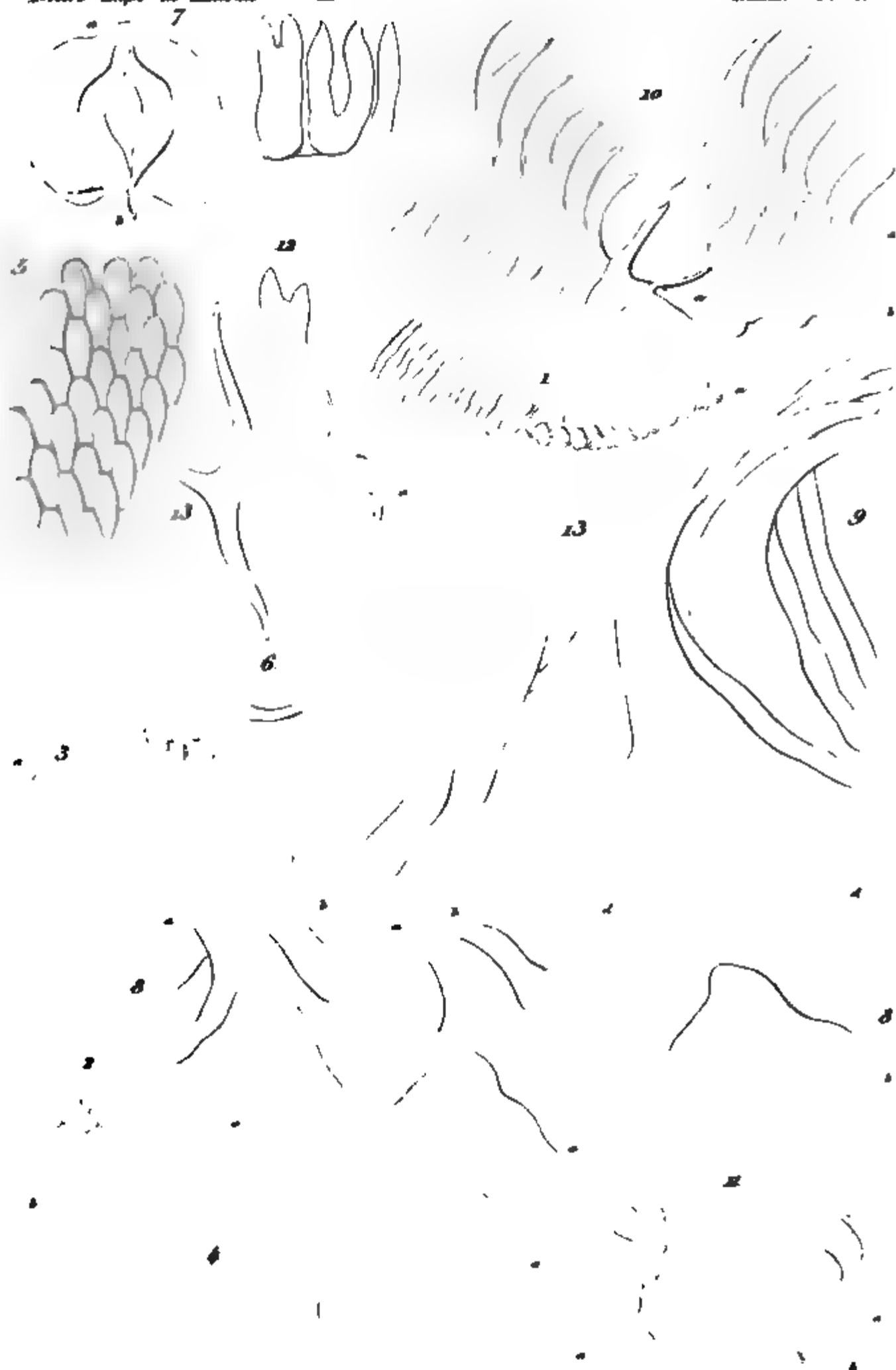




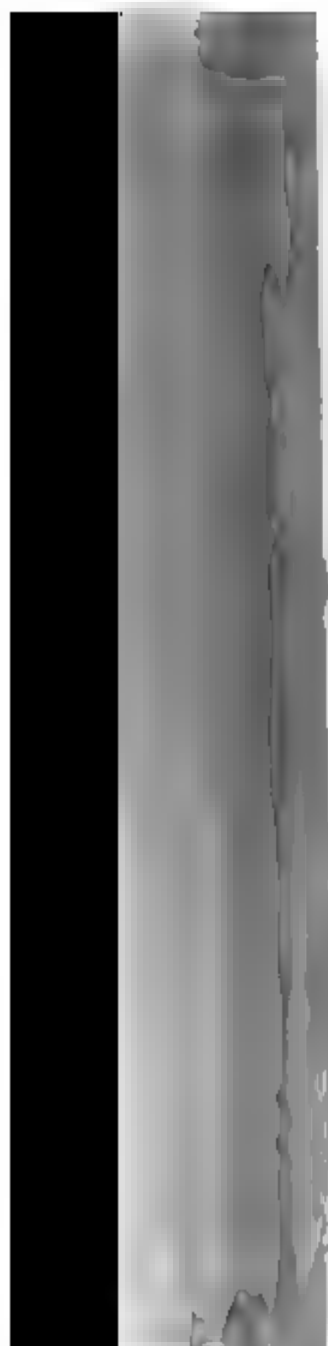
1 *Dendronotus arborascens* (F)
2 - 6 *D. Dalli*, Bgh

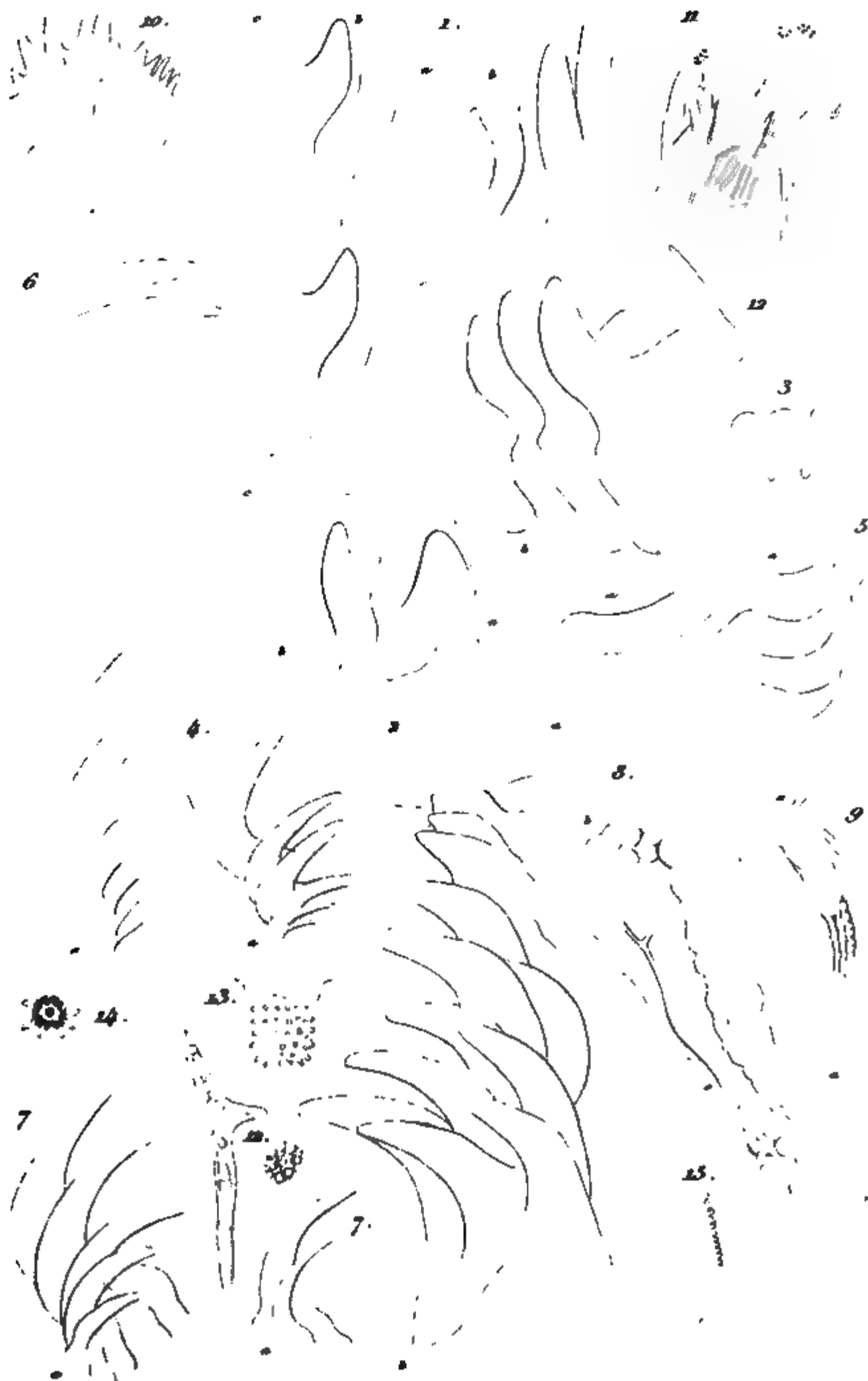
7 - 12 *D. purpureus*, B
13 - 26 *Tritonia tetraquetra* (Pallas)
Tenny Man



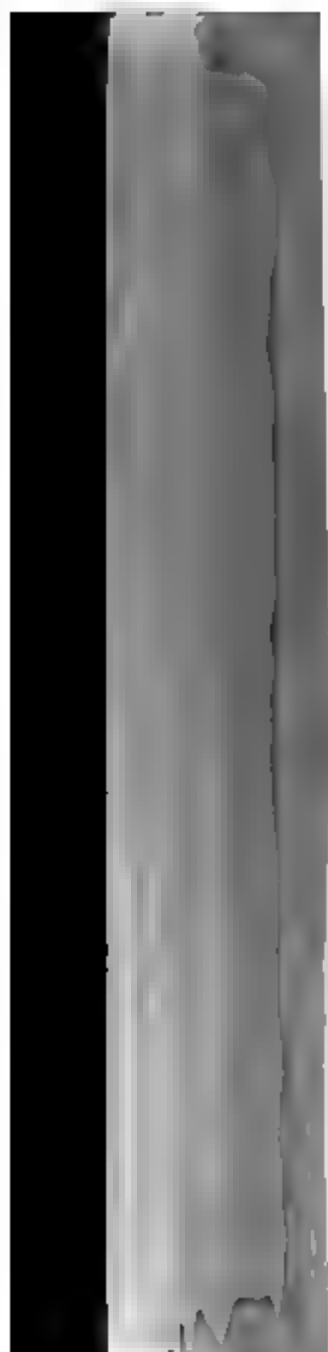


1-4 *Dendron arbor* (F) 5-12 *Trit tetractetra* (P)
13. *Alced. heterocoma*. Bgh.





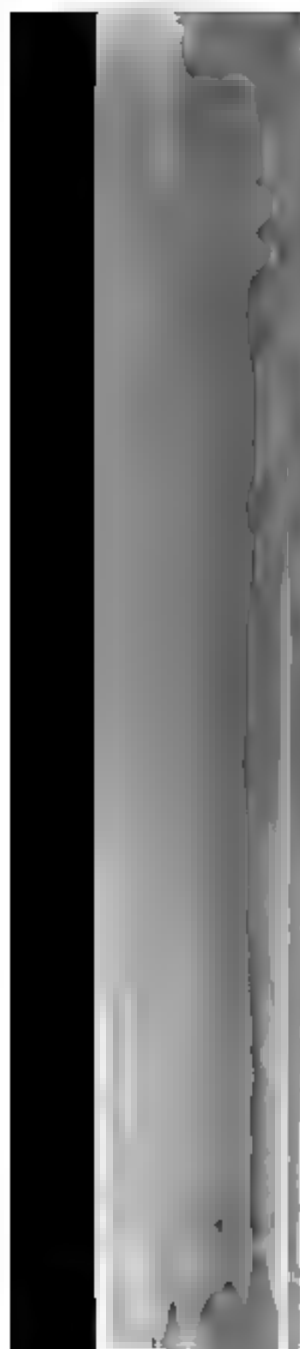
1-2. *B. heterophylla* (R.)
 3-9. *Diastylis Sandiegensis* (Cooper)
 10-14. *Abies balsamea* (L.)
 15. *Abies balsamea* (L.)





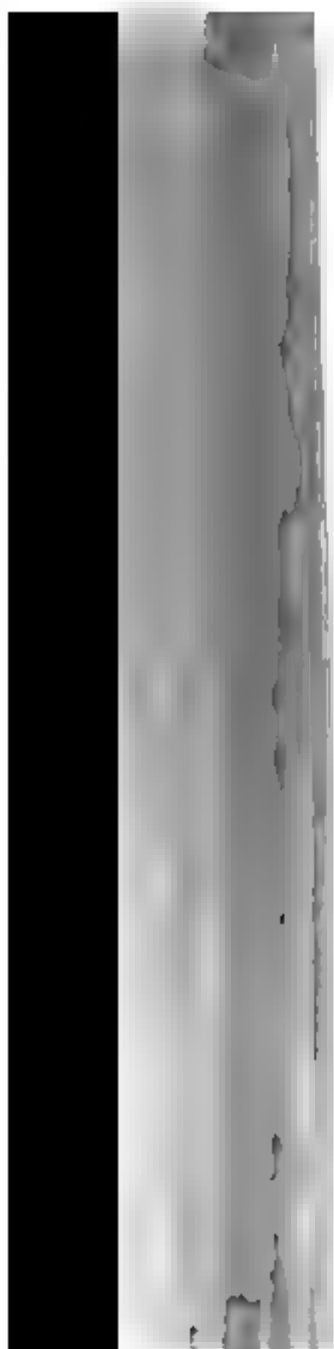
1 - 20. *Alnodoris lutescens*. Bgh.

21 - 22. *Cadlina repanda* (A. et H.)





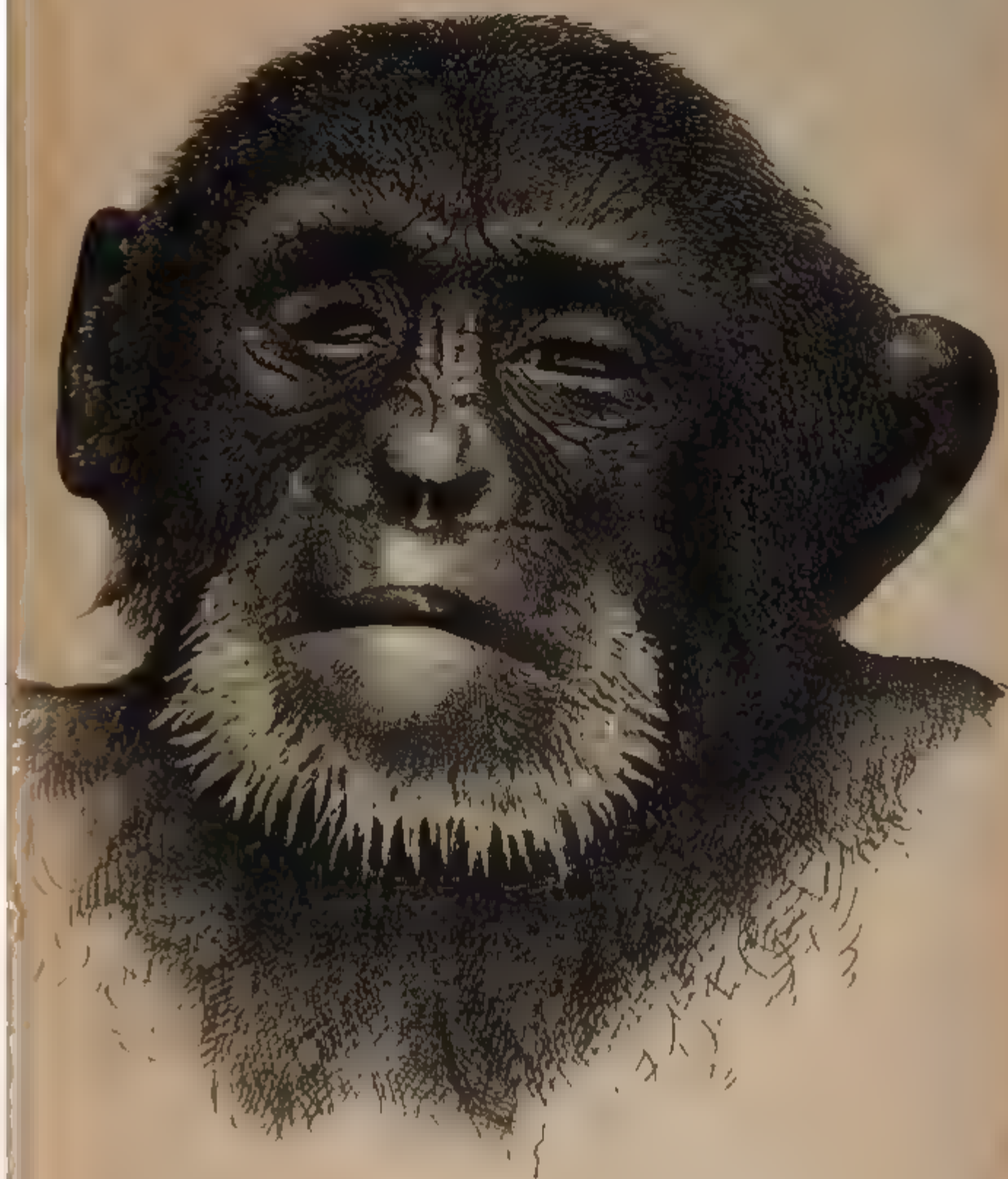
1-8 *Almod. luteo.* B 9-18 *Call. rep.* (A & E) 19-20 *C. pacifica.* B
A. high



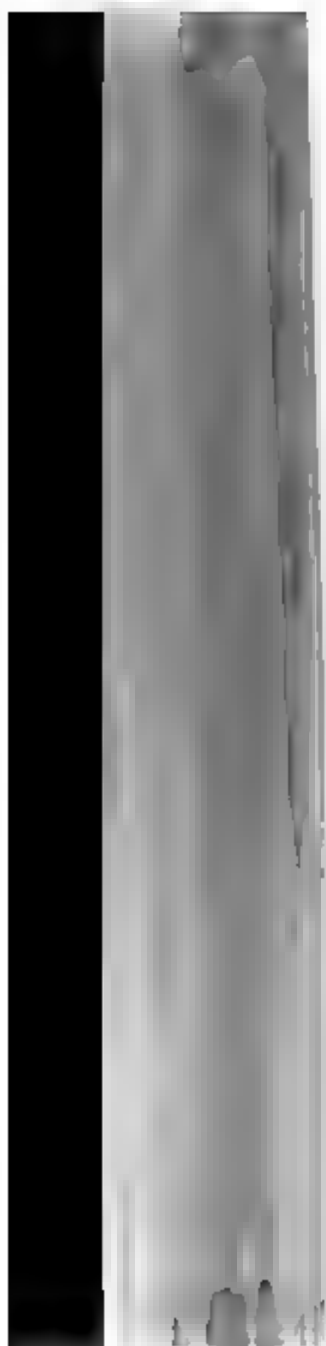


1-2 *Al. intracoma*, B. 3-6. *Call. rep* (A. & H.)
 7-18 *C. parvula*, B. 19. *Serrena Johnstoni* (A. & H.)
 20-27 *Serrena Johnstoni* (A. & H.)



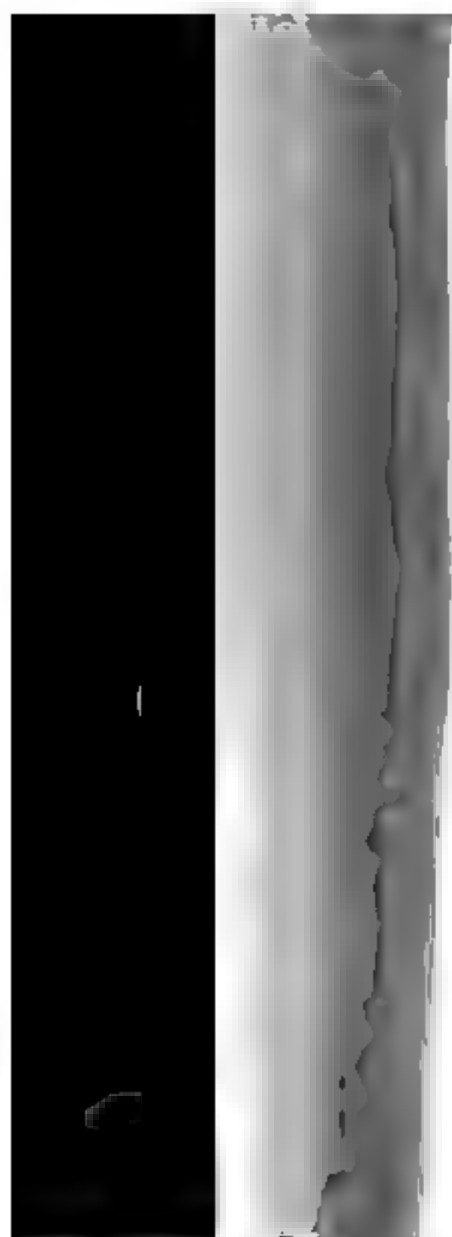


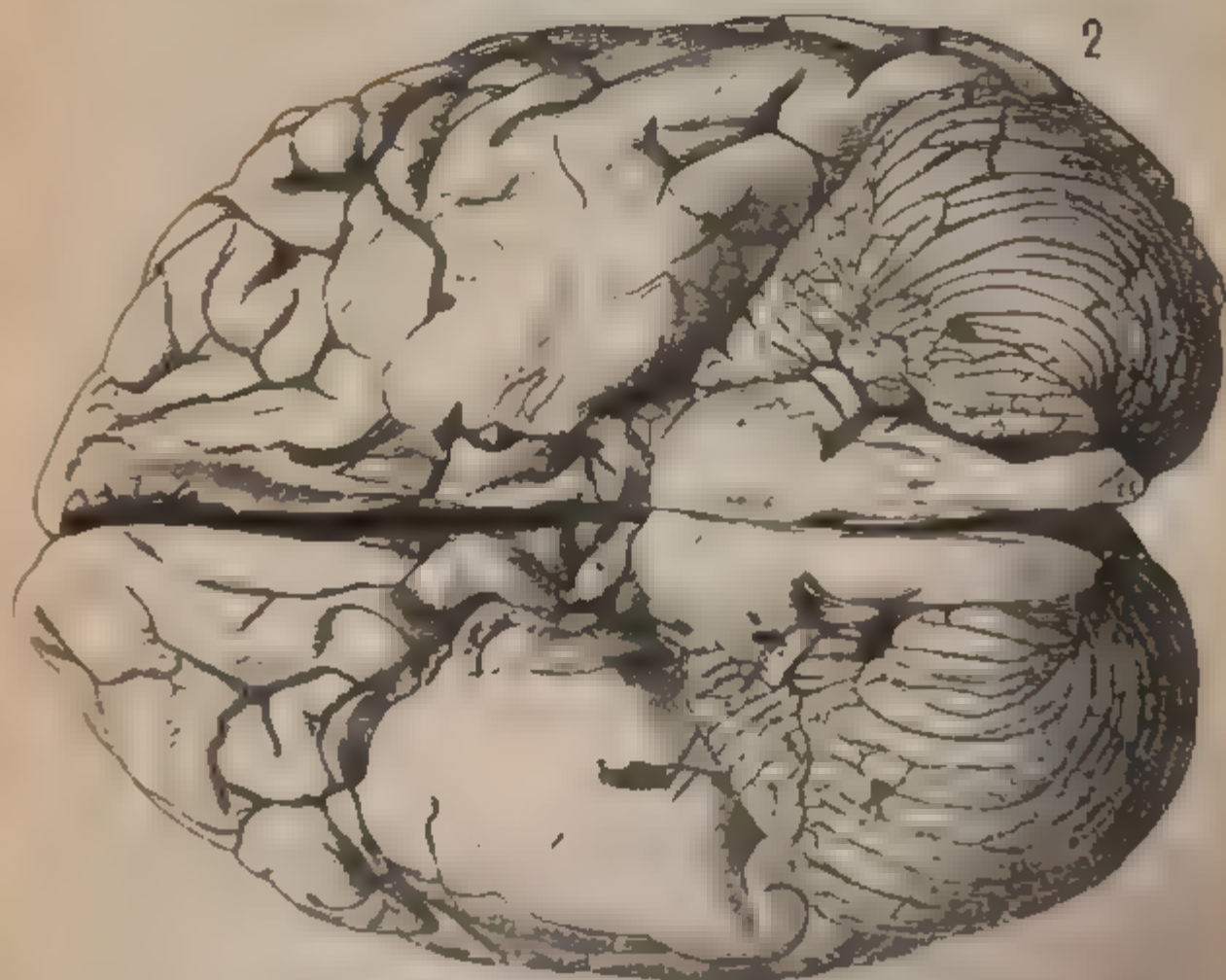
CHAPMAN ON THE CHIMPANZEE.





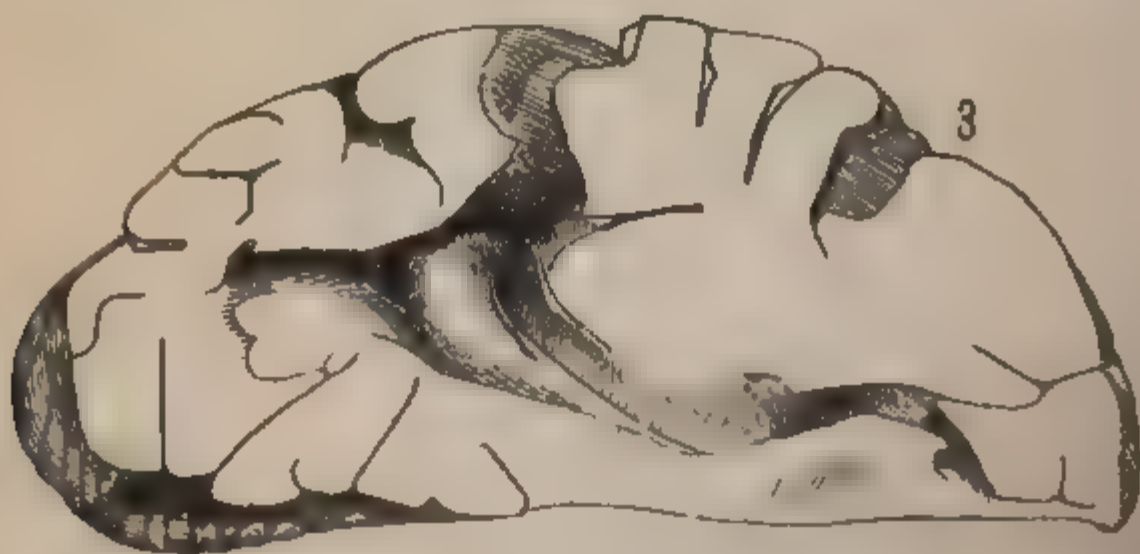
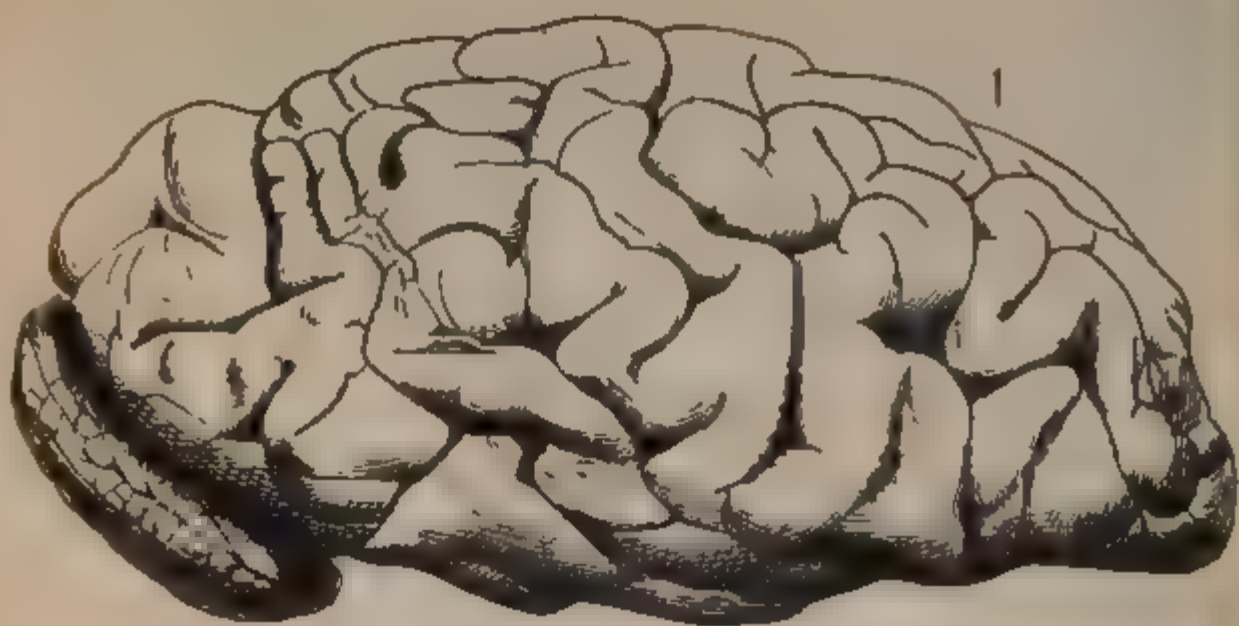
CHAPMAN ON THE CHIMPANZEE.





CHAPMAN ON THE CHIMPANZEE



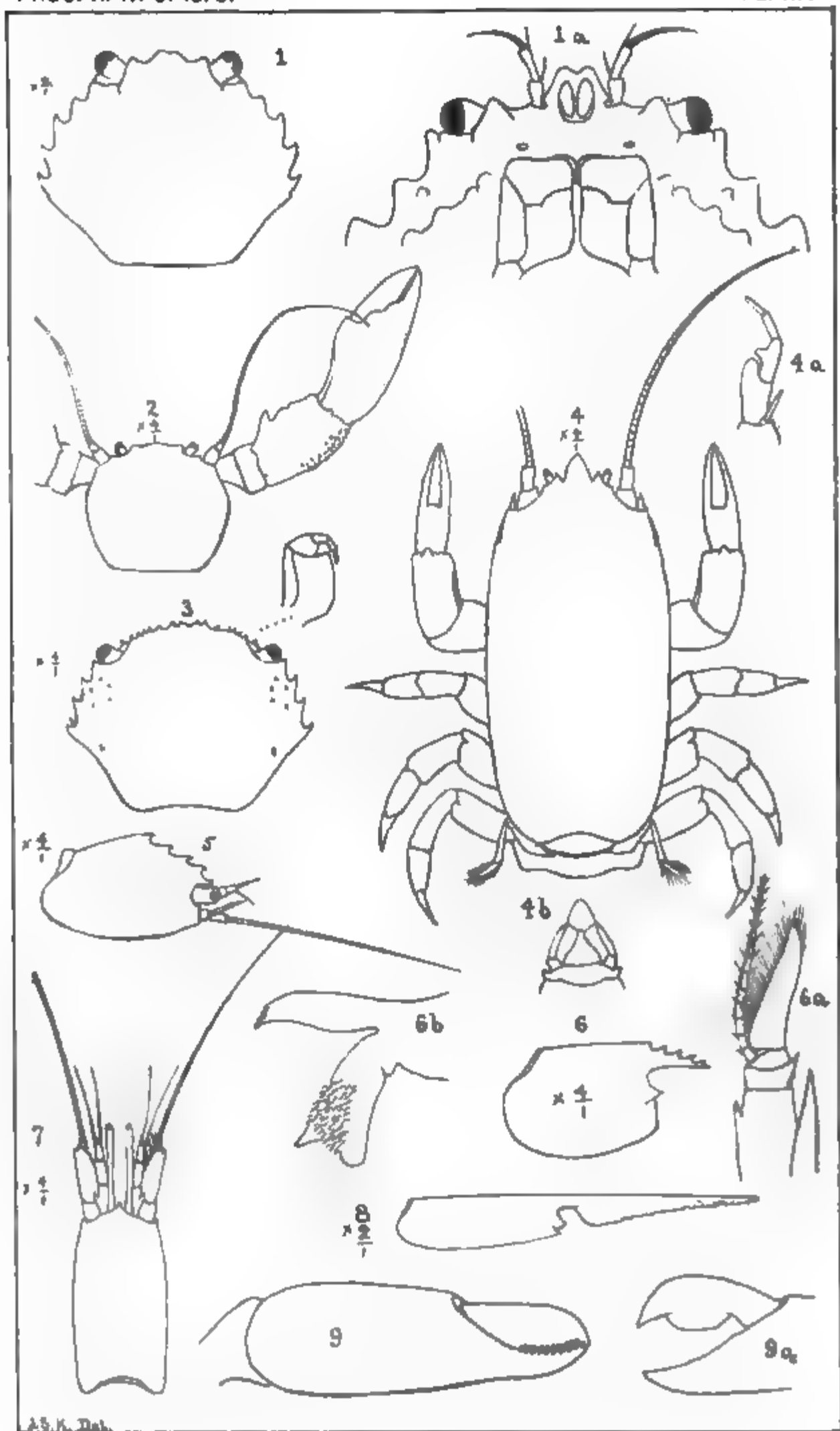


CHAPMAN ON THE CHIMPANZEE.

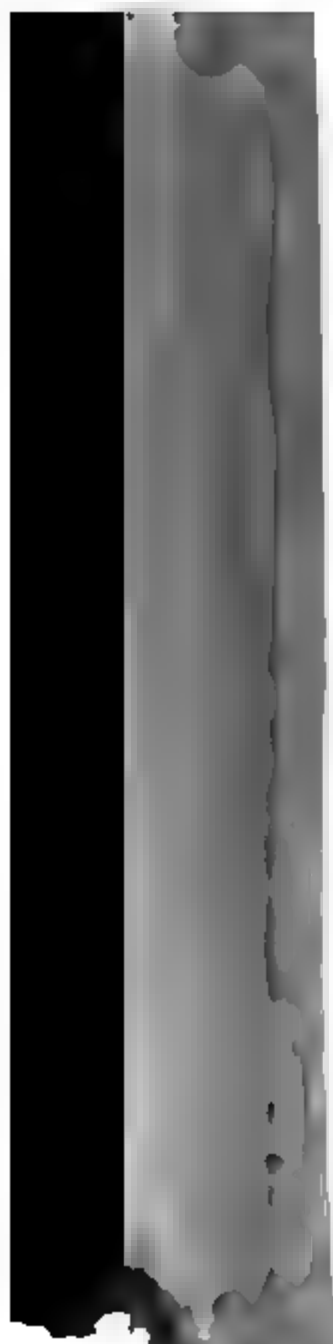


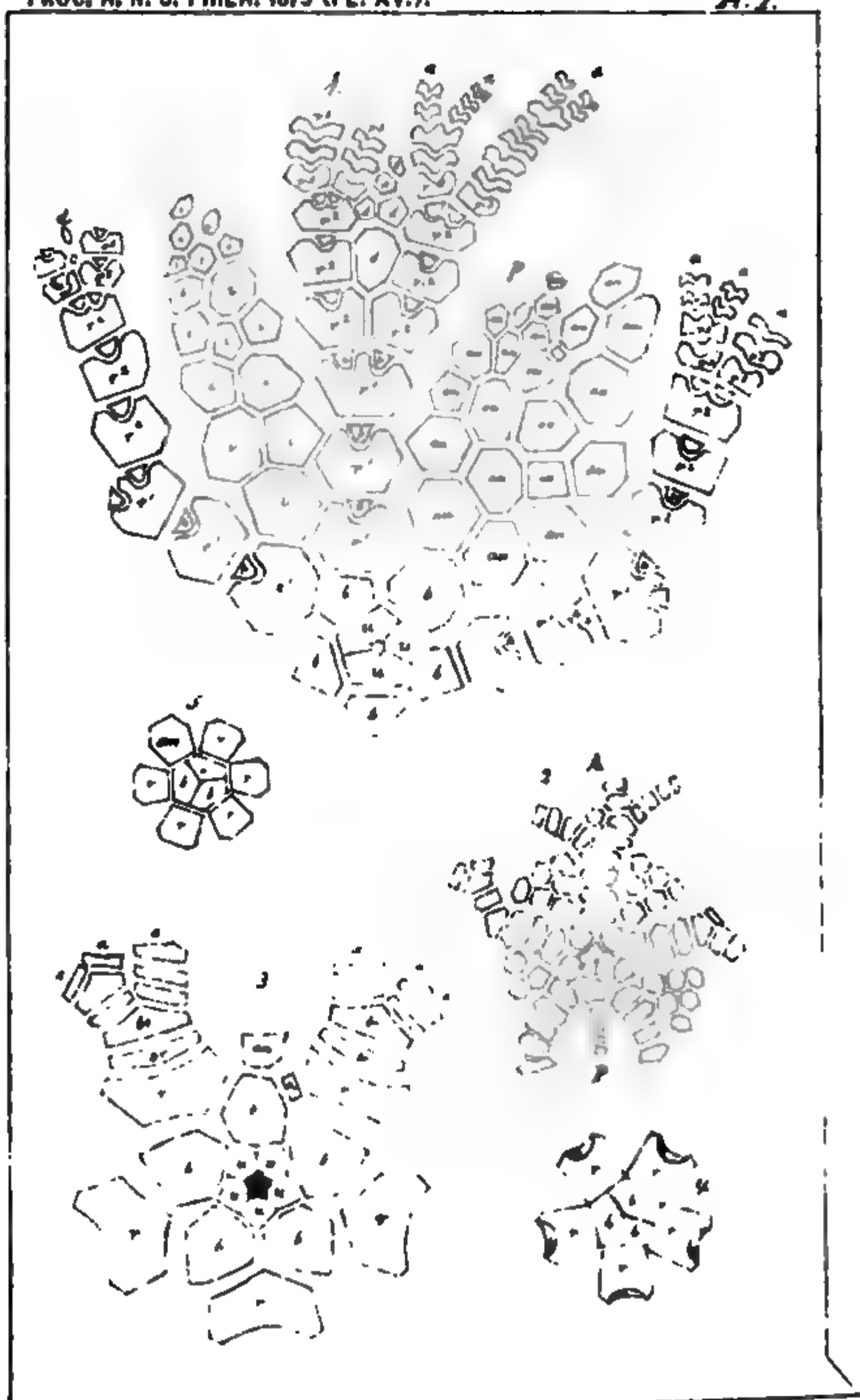




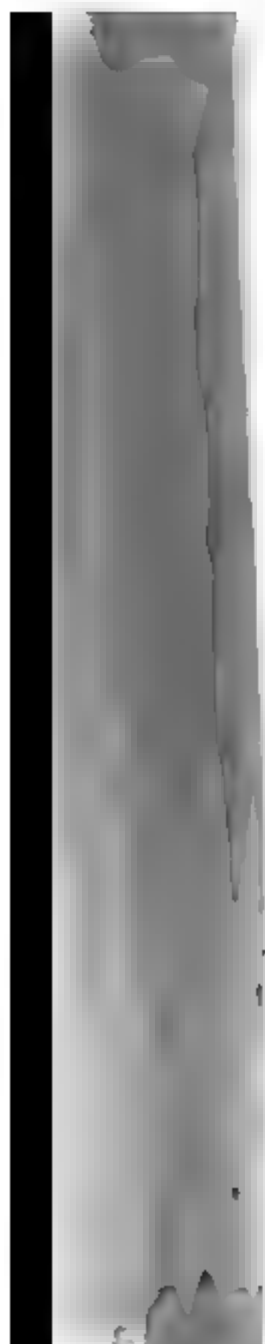


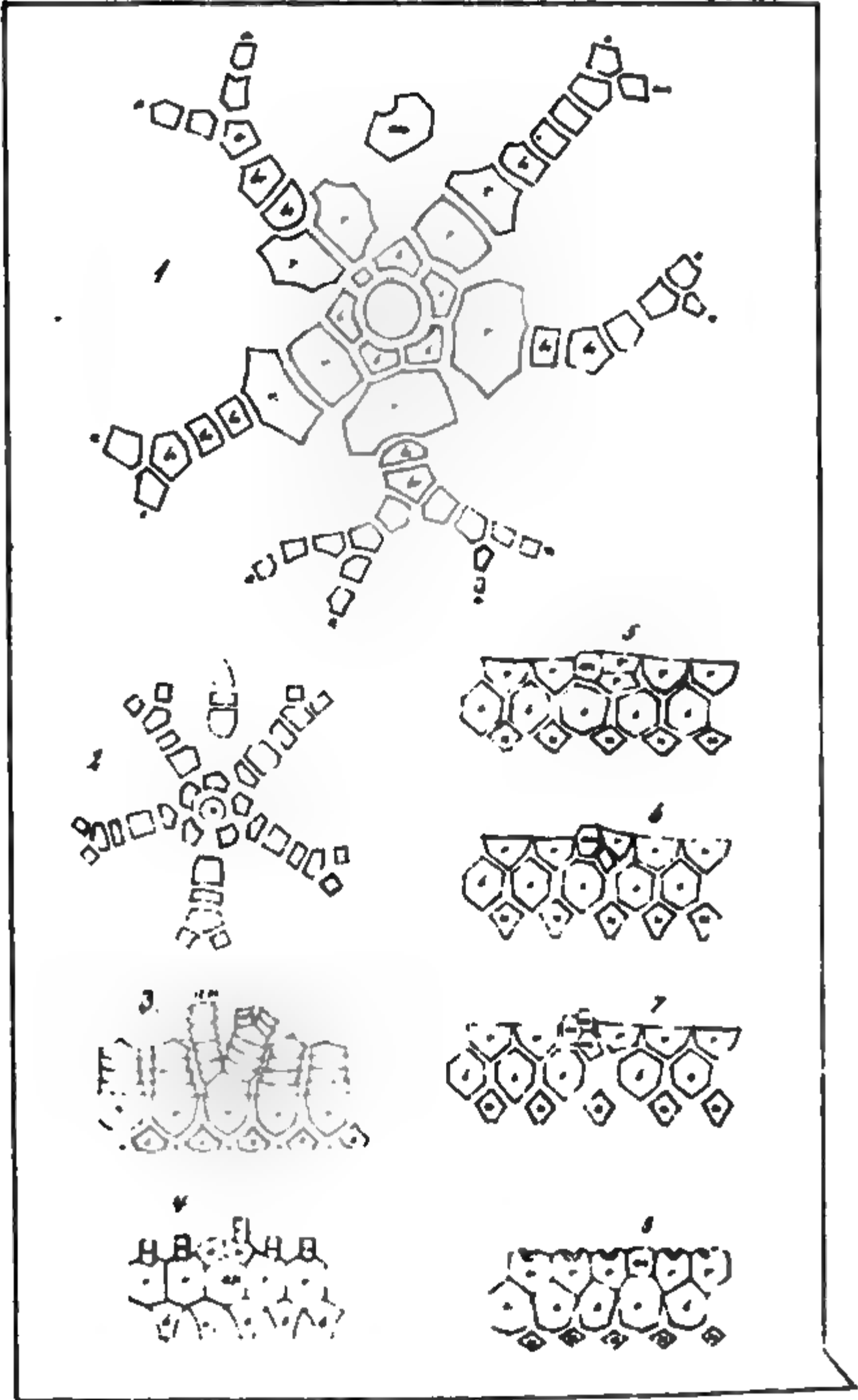
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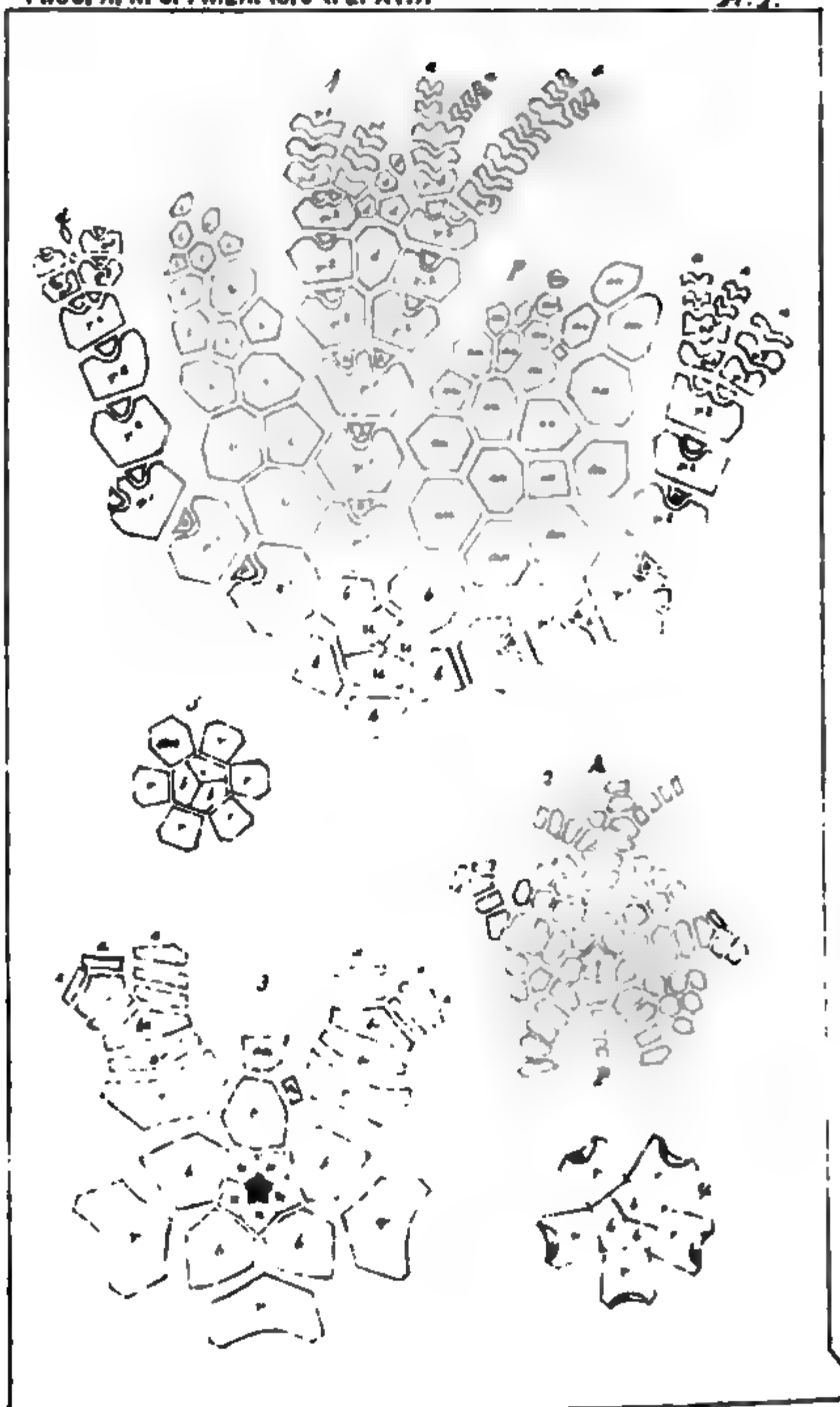
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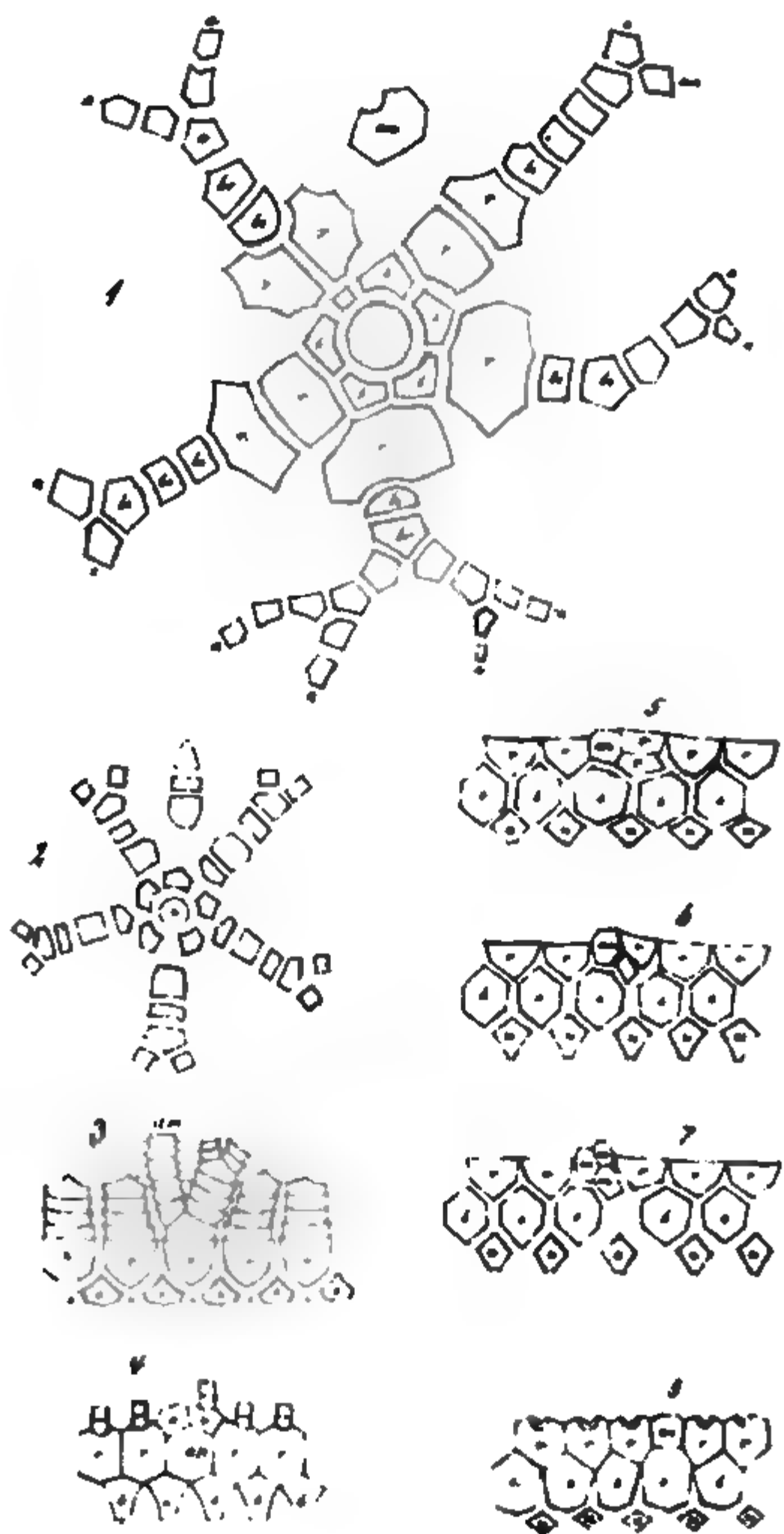
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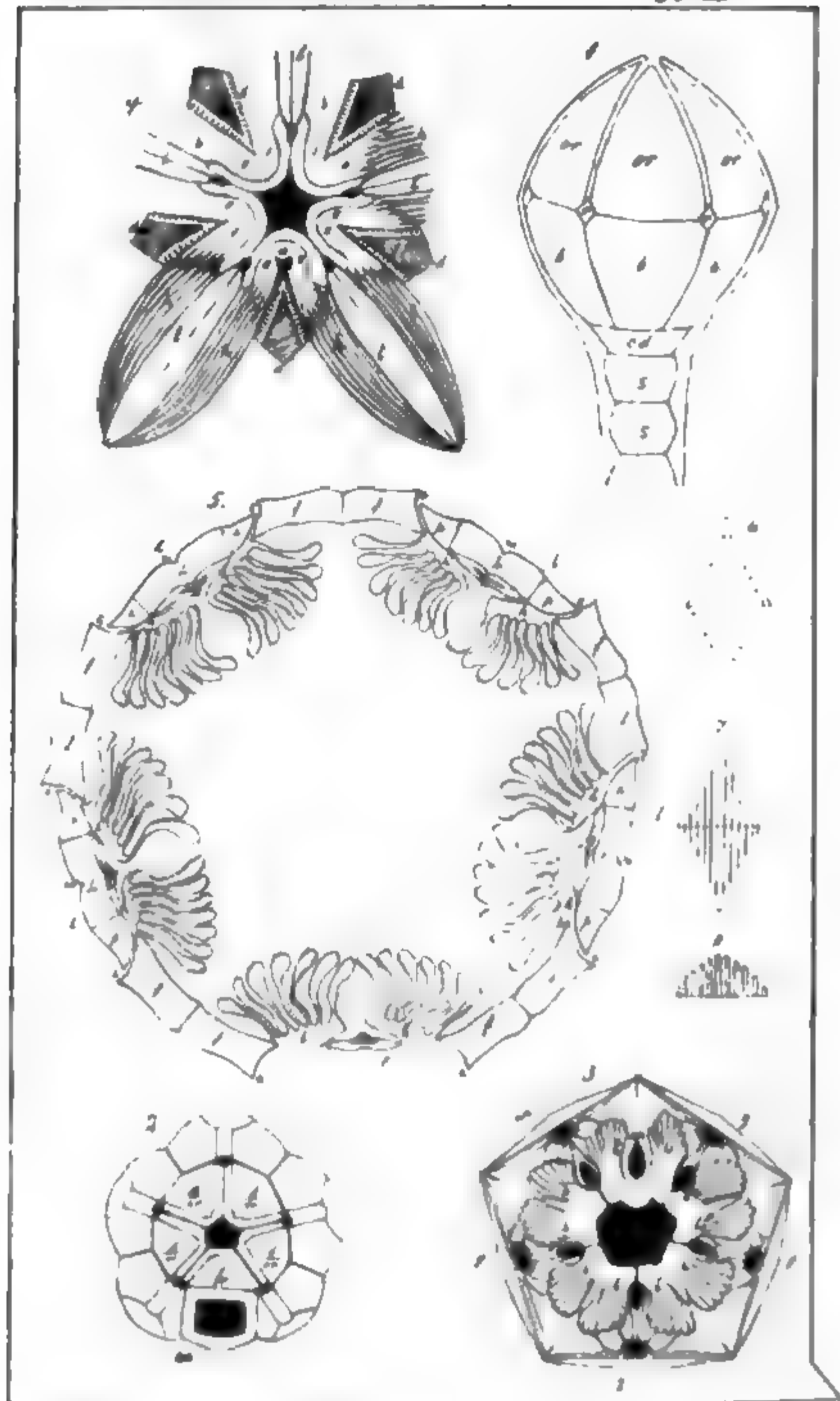
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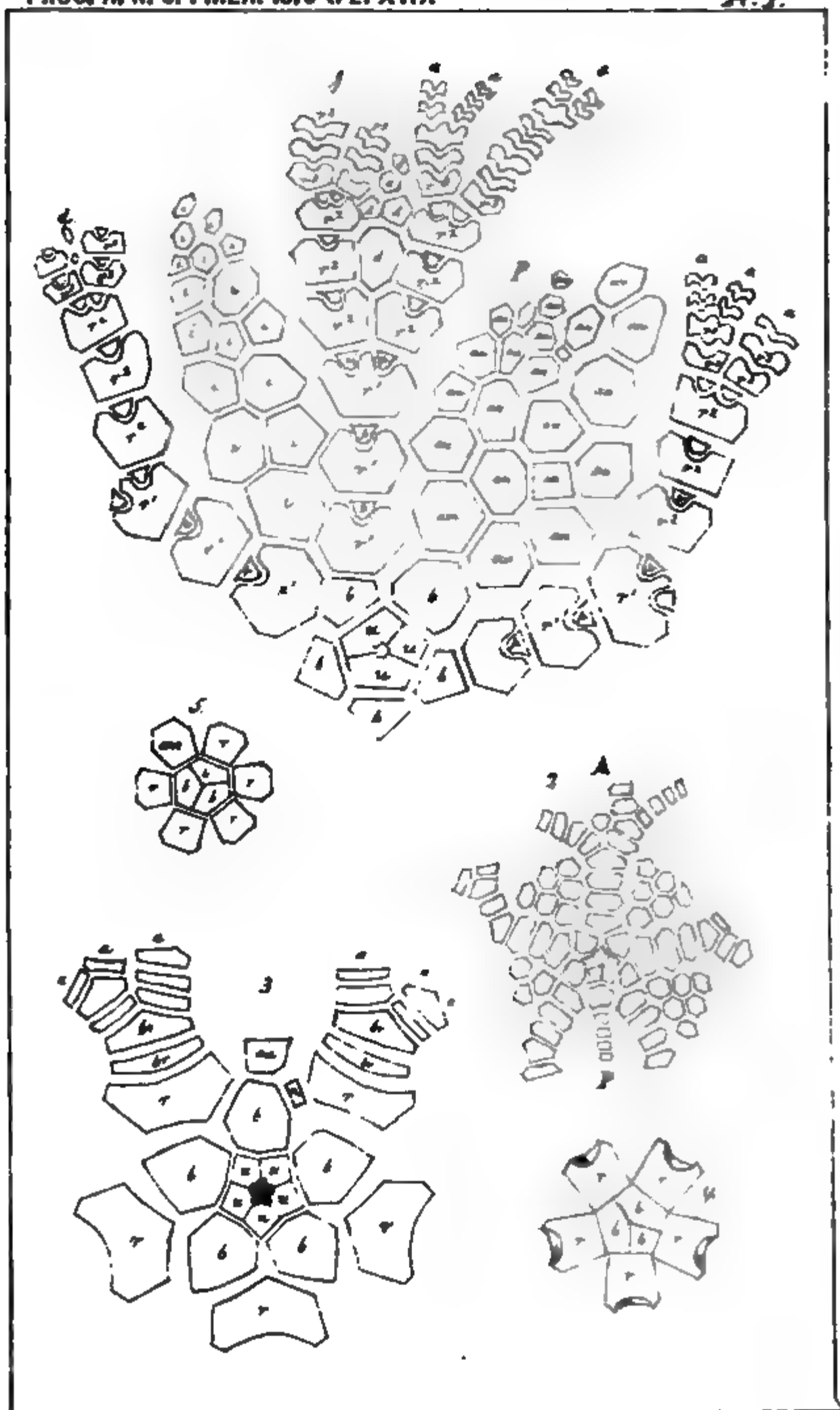
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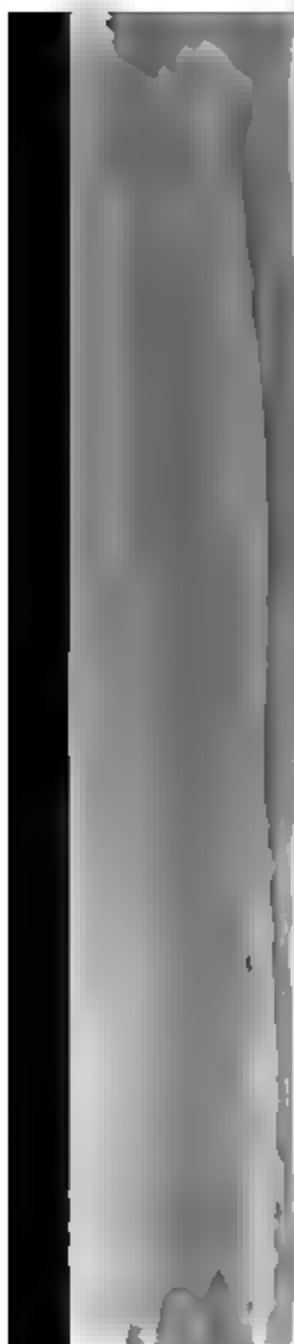


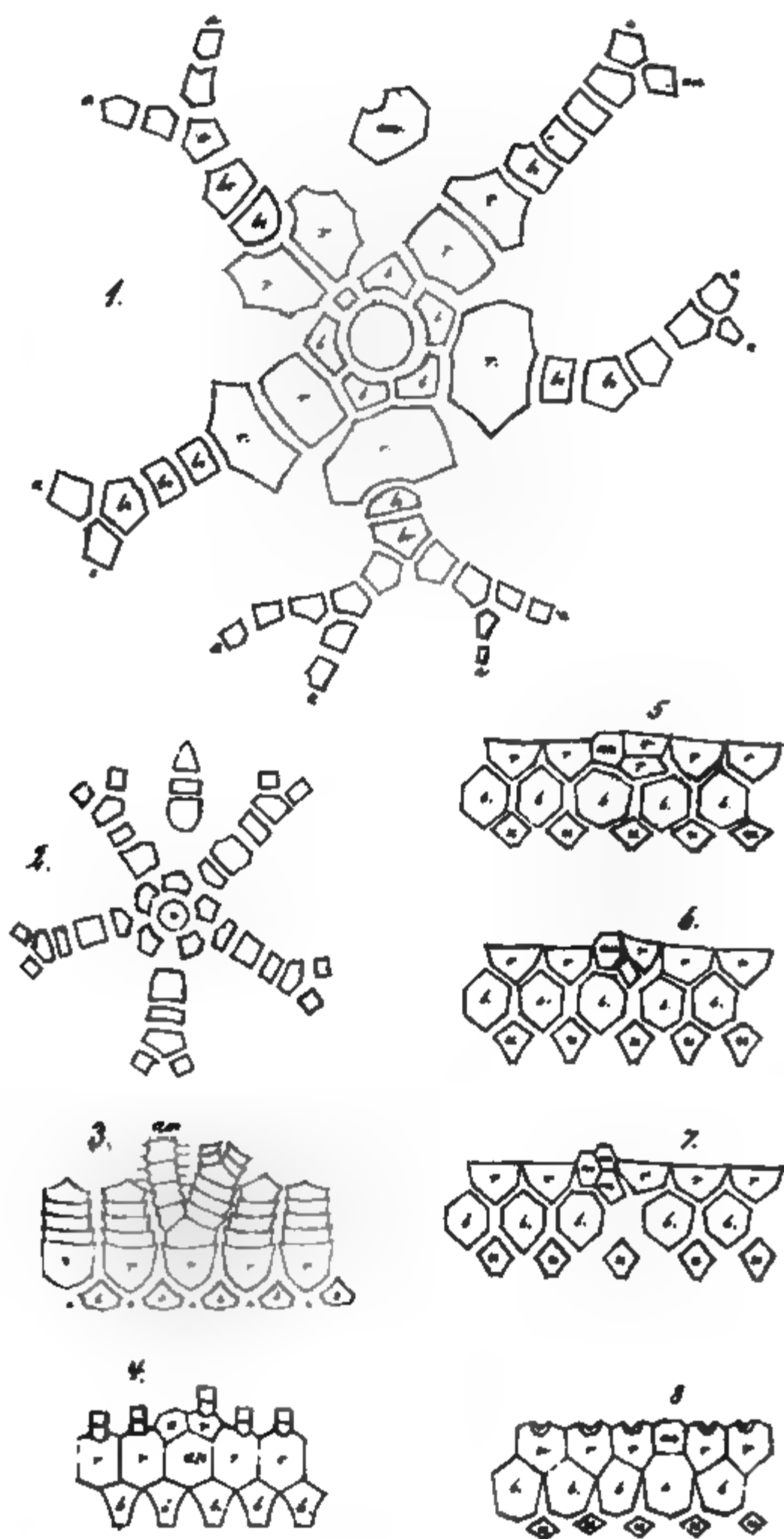
WACHSMUTH AND SPRINGER ON CRINOIDEA.



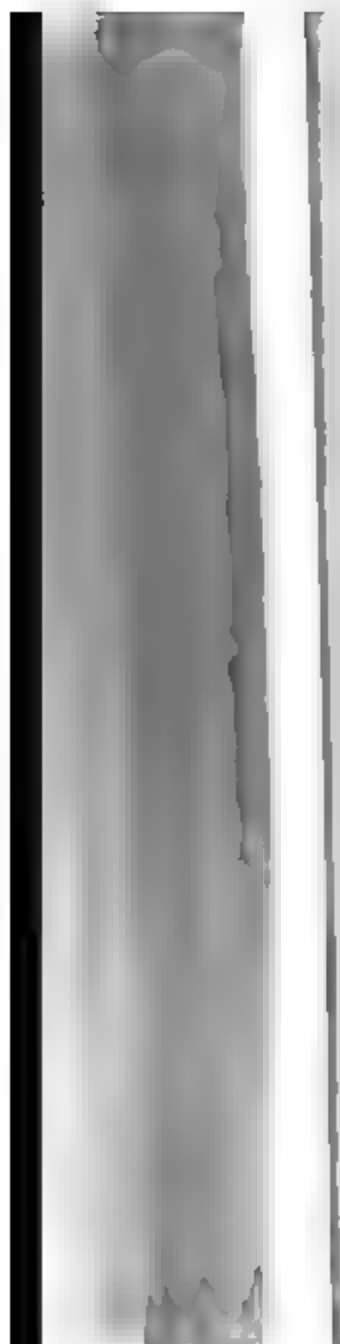


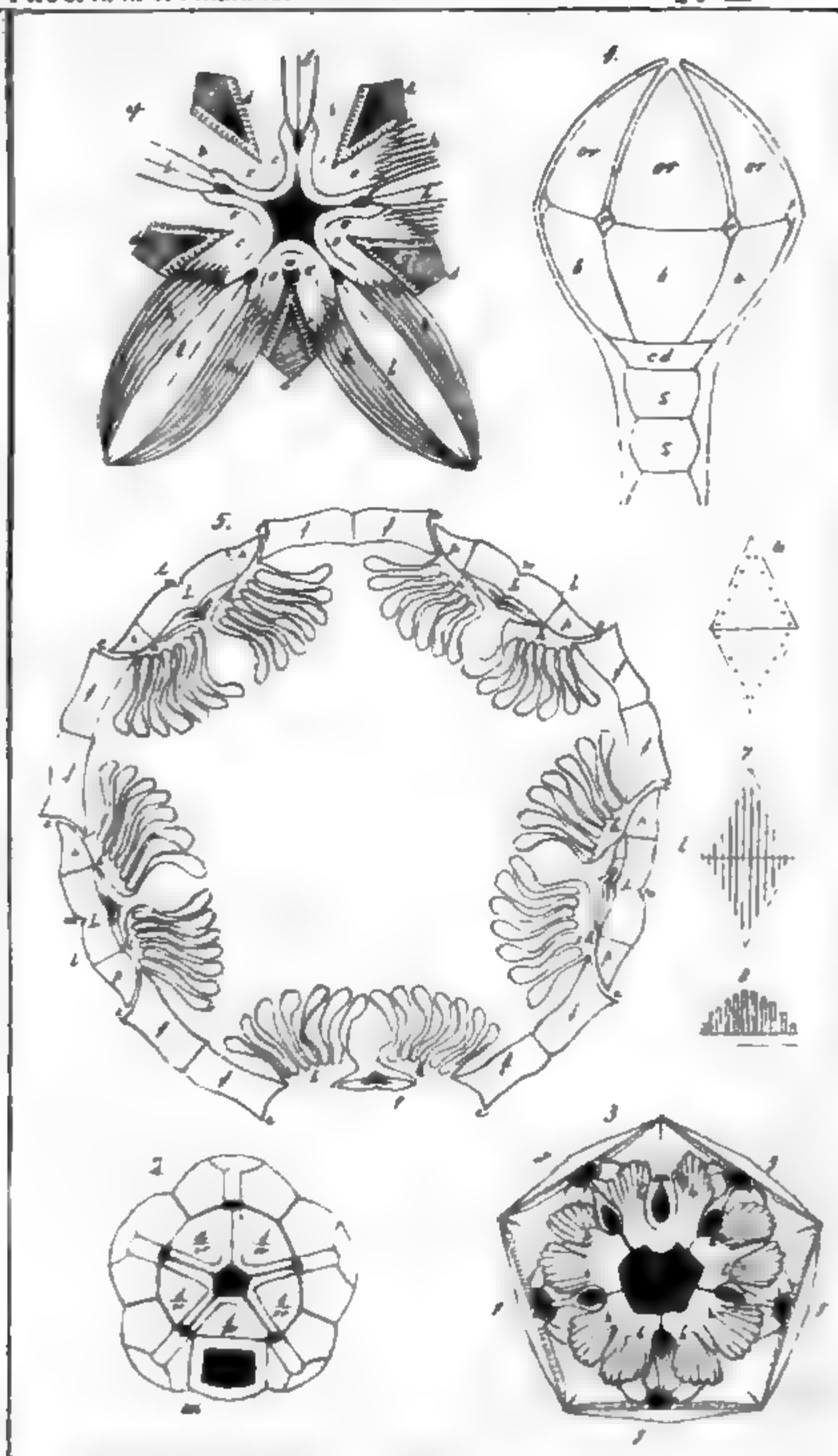
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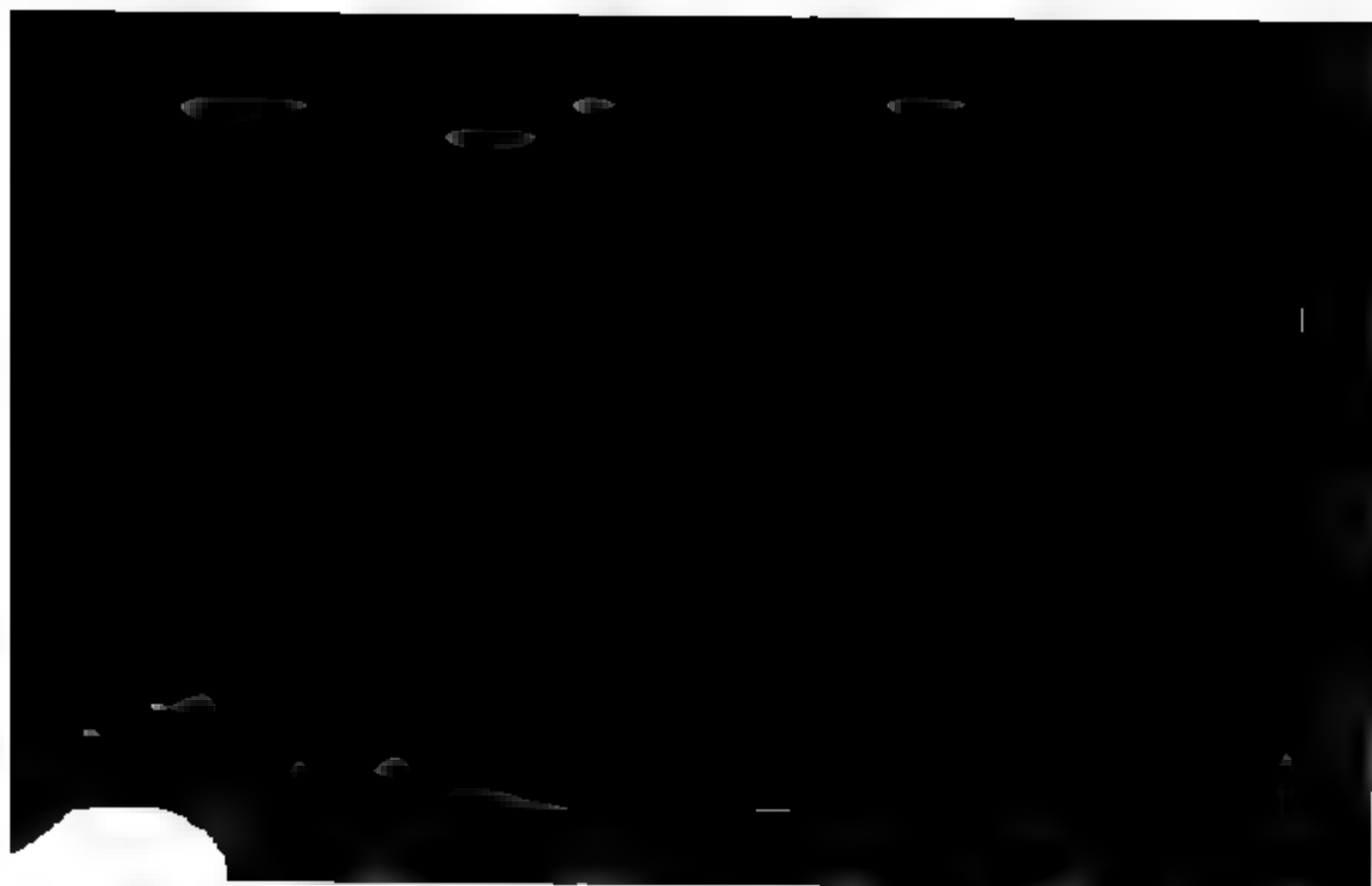


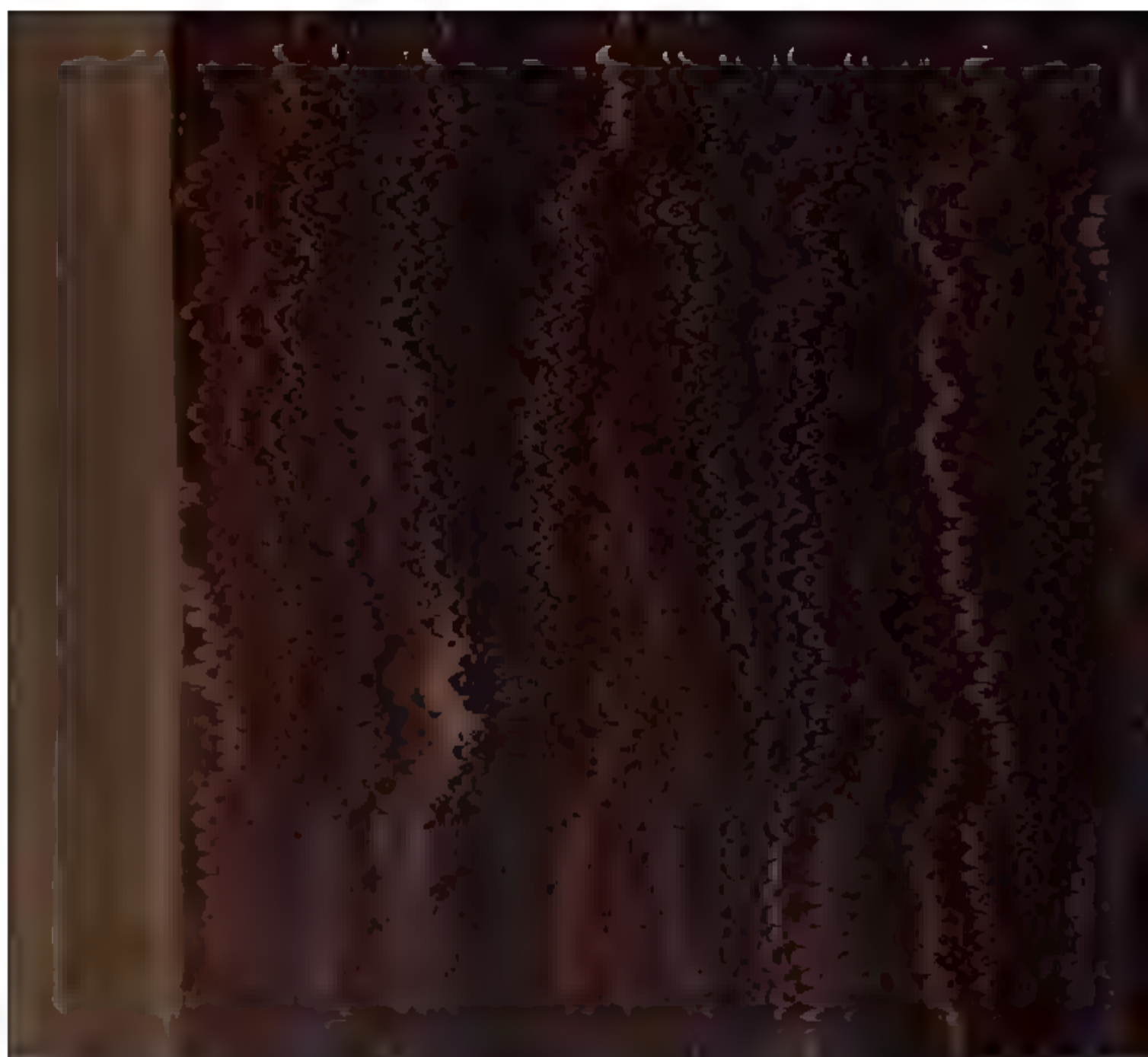


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WACHSMUTH AND SPRINGER ON CRINOIDEA.

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